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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

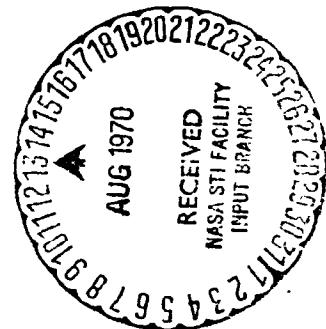
LM RENDEZVOUS PROCEDURES

D MISSION

FINAL

REVISION A

JAN 31, 1969



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RENDEZVOUS PROCEDURES

D MISSION

AS-504/CSM-104/LM-3

January 31, 1969

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D MISSION
RENDEZVOUS PROCEDURES
LM ACTIVE

1.0 Purpose

This document contains the primary procedures for the LM-3 active rendezvous with CSM 104 spacecraft, in accordance with Detailed Test Objective P20.27, defined in the Mission Requirements SPD8-R-005, Revision 1, dated November 6, 1968.

The purpose of the Rendezvous Procedures Document is to provide a single source of procedures information for use in flight planning, crew training, and preparation of onboard data.

This is a control document, subject to review by all elements of the Apollo Program, and approval by the Procedures Configuration Control Board.

2.0 Major Events

The LM3/CSM104 rendezvous occurs in the "fifth period of activities" (87 hrs to 10¹ hrs G.E.T.). The procedures in this period will be divided into segments around major activities, and discussed separately in the paragraphs of Section 2.0.

Figure 2-1 shows the LM attitude time history and the locations in time and position of the 50 major events of the nominal mission.

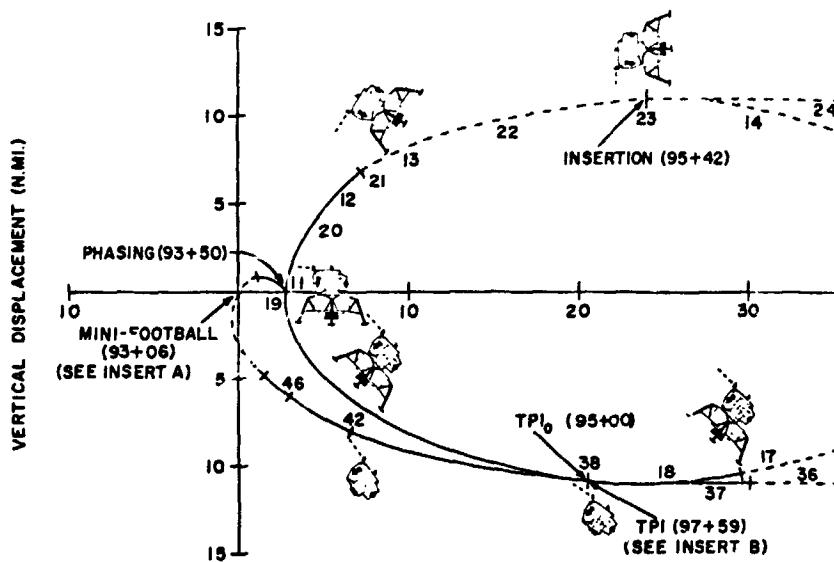


FIGURE 2-1
"D" MISSION RENDEZVOUS PROFILE
(CSM-CENTERED RELATIVE MOTION)

LM MAJOR EVENTS

1	92+41	UNDOCKING	26	96+04	AGS TARG
2	92+44	I20 YAW RT, 90 PITCH UP	27	96+15	AGS UPDA
3	92+50	LM INSPECTION (360 YAW)	28	96+22	STAGE
4	93+06	RCS SEPARATION (CSM ACTIVE)	29	96+22	CSI THRU
5	93+07	AGS UPDATE AND ALIGN (R47)	30	96+29	CDH TARG
6	93+08	R/R CHECKOUT	31	96+30-96+54	R/R NAVIG
7	93+15	EXT AV FOR DPS PHASING (P30)	32	96+57	AGS UPDA
8	93+18	IMU REFSMMAT ALIGN (P52)(COAS CALIBRATION)	33	97+06	CDH THRU
9	93+39	AGS UPDATE AND ALIG (R47)	34	97+13	TPI TARG
10	93+47	LR SPUR TEST (V76)	35	97+14-97+48	R/R NAVIG
11	93+50	DPS PHASING (P40 AND AGS CONTROL)	36	97+50	AGS UPDA
12	93+58	TPI ₀ TARGETING (P34)	37	97+55	CALCULATI
13	94+00-94+15	R/R NAVIGATION (P20, 12 MARKS)	38	97+59	TPI THRU
14	94+16	LR SELF TEST	39	98+04	MCCI TARG
15	94+26	TPI ₀ TARGETING (P34)	40	98+02-98+06	R/R NAVIG
16	94+30-94+48	R/R NAVIGATION (P20, 15 MARKS)	41	98+06	CALCULAT
17	94+51	GO, NO GO FOR INSERTION	42	98+08	MCCI THR
18	94+52	IMU REFSMMAT ALIGN (P52)	43	98+11	MCCI TAR
19	95+20	MONITOR CLOSE APPROACH	44	98+12-98+18	R/R NAVIG
20	95+22	EXT AV FOR DPS INSERTION (P30)	45	98+20	CALCULAT
21	95+34	AGS UPDATE AND ALIGN (R47)	46	98+21	MCCI THA
22	95+36	LR SPUR TEST (V76)	47	98+30	BRAKING
23	95+42	DPS INSERTION (P40 AND AGS CONTROL)	48	98+38	STATION
24	95+51	CSI TARGETING (P32)	49	98+47	R/R OFF
25	95+50-96+12	R/R NAVIGATION (P20, 16 MARKS)	50		DOCK

FOLDOUT FRAME /

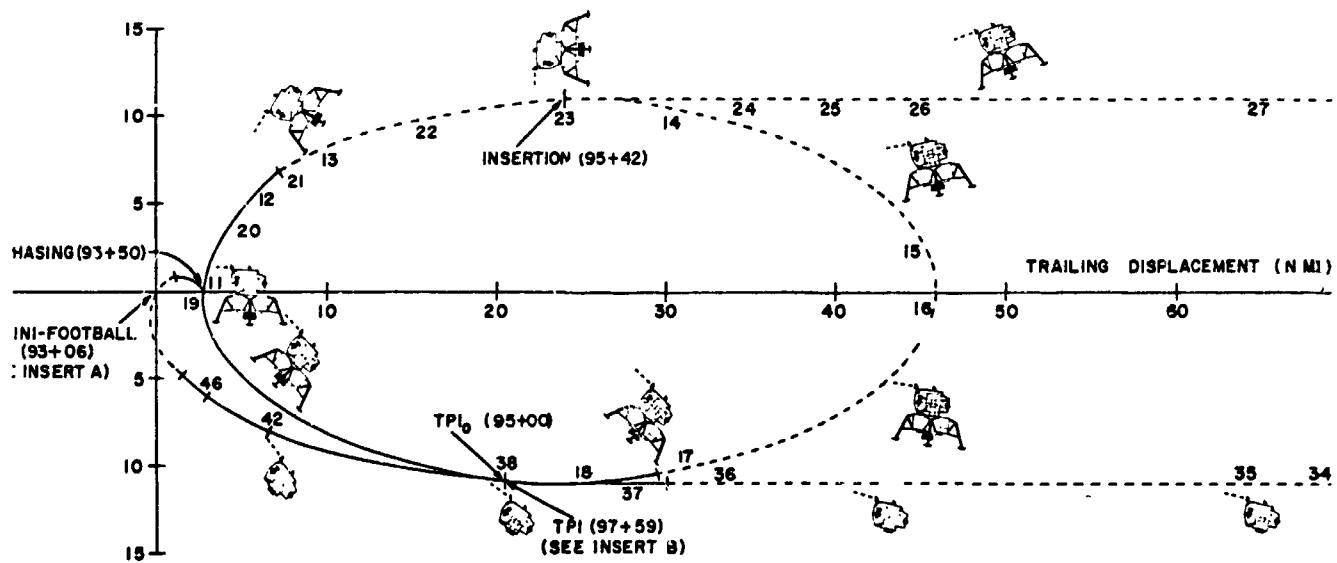
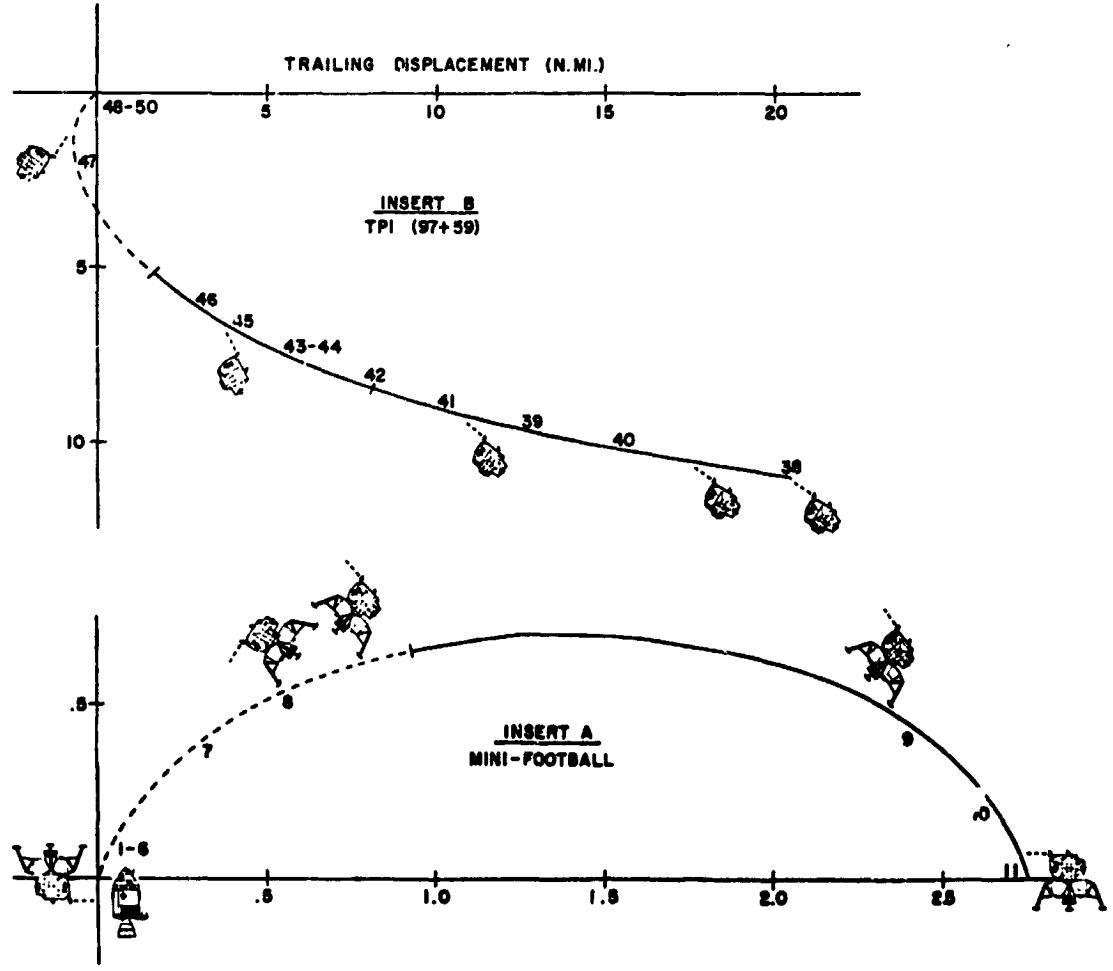
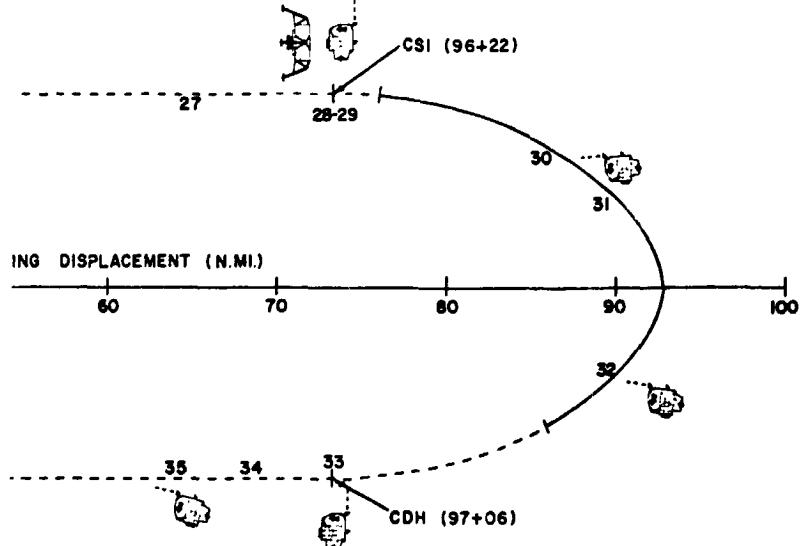


FIGURE 2-1
MISSION RENDEZVOUS PROFILE
(CSM-CENTERED RELATIVE MOTION)

LM MAJOR EVENTS

-41	UNDOCKING	26	96+04	AGS TARGETING
-44	120 YAW RT, 90 PITCH UP	27	96+15-	AGS UPDATE AND ALIGN (R47)
-50	LM INSPECTION (360 YAW)	28	96+22	STAGE
-06	RCS SEPARATION (CSM ACTIVE)	29	96+22	CSI THRUSTING (P41)(APS INTERCONNECT)
-07	AGS UPDATE AND ALIGN (R47)	30	96+29	CDH TARGETING (P33)
-08	R/R CHECKOUT	31	96+30-96+54	R/R NAVIGATION (P20, 20 MARKS)
-15	EXT AV FOR DPS PHASING (P30)	32	96+57	AGS UPDATE AND ALIGN (R47)
-18	IMU REFSMMAT ALIGN (P52)(COAS CALIBRATION)	33	97+06	CDH THRUSTING (P42)
-39	AGS UPDATE AND ALIGN (R47)	34	97+13	TPI TARGETING (P34)
-47	LR SPUR TEST (V78)	35	97+14-97+48	R/R NAVIGATION (P20, 26 MARKS)
-50	DPS PHASING (P40 AND AGS CONTROL)	36	97+50	AGS UPDATE AND ALIGN (R47)
-58	TPI ₀ TARGETING (P34)	37	97+55	CALCULATE BU SOLUTION (TPI)
-94+15	R/R NAVIGATION (P20, 12 MARKS)	38	97+59	TPI THRUSTING (P41)
+16	LR SELF TEST	39	98+04	MCCI TARGETING (P35)
+28	TPI ₀ TARGETING (P34)	40	98+02-98+08	R/R NAVIGATION (P20, 4 MARKS)
-94+48	R/R NAVIGATION (P20, 15 MARKS)	41	98+08	CALCULATE BU SOLUTION (MCCI)
+51	GO, NO GO FOR INSERTION	42	98+09	MCCI THRUSTING (P41)
+52	IMU REFSMMAT ALIGN (P52)	43	98+11	MCCB TARGETING (P35)
+20	MONITOR CLOSE APPROACH	44	98+12-98+18	R/R NAVIGATION (P20, 6 MARKS)
+22	EXT AV FOR DPS INSERTION (P30)	45	98+20	CALCULATE BU SOLUTION (MCCB)
+34	AGS UPDATE AND ALIGN (R47)	46	98+21	MCCB THRUSTING (P41)
+38	LR SPUR TEST (V78)	47	98+30	BRAKING (P47)
+42	DPS INSERTION (P40 AND AGS CONTROL)	48	98+35	STATION KEEPING
+51	CSI TARGETING (P32)	49	98+47	R/R OFF
-96+12	R/R NAVIGATION (P20, 18 MARKS)	50		DOCK

FOLDOUT FRAME 2



FOLDOUT FRAME 3

1 Undocking Maneuver

By 89:50 hrs G.E.T. both crewmen have entered the LM, powered up the PGNS, IMU, and AGS, and closed the hatch in preparation for the undocking. At about 91:10 over Artigua the PGNS state vector is updated. The first rendezvous related activity begins with the docked IMU align which has been preceded by a ground uplink of the REFSMMAT into the LM Guidance Computer (LGC). The docked align is accomplished without using Program 51 and 52 procedure by manually setting the REFSMMAT flag and commanding a Verb 42 to fine align. The ICDU angles used in Verb 42 are computed from the CSM's Noun 20 and the docking ring index angle with an equation similar to that given in the AOH Vol II Section 4.9. The Rendezvous Radar antenna restraint device is released and the radar self test routine executed. Meanwhile, the CSM has begun a maneuver to the undocking attitude. LM procedures up to this point are included in the crew checklist. Undocking occurs at 92:41 with the CSM backing away to about 50 feet (giving clearance for LM maneuvers), while maintaining an inertial attitude. At this time the LM will yaw right 120 degrees and pitch up 180 degrees in order for the CSM to photograph the descent engine bell, then pitch down 90 degrees under AGS control to position the LM plus Z-axis toward the CSM.

2.2 RCS Separation Maneuver

The LM is placed in AGS attitude hold (pitch, roll) and a yaw rate of approximately 1 degree/second is commanded with AGS minimum impulses. This yaw rate is held for 360 degrees, so that the CSM can visually inspect all legs of the LM landing gear and descent engine bell. When the LM plus Z-axis is again pointed at the CSM, the yaw rate is stopped and the LM enters PGNS attitude hold and begins station keeping. The attitudes of both vehicles during the inspection have been established to provide illumination of the LM surface from reflected sunlight.

At 93:05:45 the CSM performs a 5 feet/second radially downward burn to allow safe separation from the LM during IMU alignment prior to the phasing burn. The LM crew accomplishes Target Delta V (Verb 84) to update the LGC with the maneuver just accomplished by the CSM.

Phasing Maneuver

Rendezvous radar acquisition using Verb 41 Noun 72 (lock-on option) is checked by manually maneuvering to point the LM plus Z-axis at the CSM and designating the antenna to the plus Z-axis. After determining that the radar is locked on the main lobe, the tape meter is calibrated using rendezvous radar self test (Verb 62). After lock-on is accomplished and radar operation verified, the radar antenna is positioned clear of the AOT field of view and turned off. While awaiting sunset, External Delta V (Program 30) is loaded with the parameters of the phasing burn and the event timer is set counting down to this maneuver.

A REFSMMAT alignment (Program 52) is performed just prior to sunset using the center forward detent position. Manual star selection is used with automatic vehicle maneuvering. Before terminating Program 52, the COAS is calibrated for future use. The rendezvous radar is turned on and an AGS state vector update and AGS alignment is accomplished followed by an AGS external Delta V targeting.

The landing radar (LR) is activated and placed in the proper configuration for a LR spurious test (Routine 77). This test is started with a Verb 78 prior to descent propulsion system (DPS) thrusting and terminated by a Verb 79 after the DPS thrusting.

The sequence of the phasing burn is started with selection of Program 40. This program will be used to monitor the maneuver which is executed under AGS control. LM guidance is switched to AGS control at about 3 minutes prior to ignition, after insuring that the ATT CONT switches are in PULSE. Configuring the ATT CONT switches in PULSE prior to switching GUID CONT from PGNS to AGS assures that unexpected high maneuver rates are not commanded by the AGS. AGS attitude error signals are displayed on the FDAO needles when the MODE CONT switch is placed to AUTO and are nulled with AGS pulses. When these errors are nulled, the ATT CONT switches are placed to MODE CONT which enables AGS auto steering. The ABORT button is depressed, manual ullage is initiated, and the burn is executed under AGS control. Upon thrust termination, the PGNS residuals are nulled with RCS thrusting.

TPI_o Targeting

When range has opened to 19,000 feet, rendezvous radar tracking with LGC updating is initiated. Program 34 (TPI) is called and targeted for a possible abort from the equi-period. The program is recycled to compute a solution for resetting the event timer. The AGS is targeted for the PGNS computed TPI time based on the LGC elevation angle option. There are few Guidance and Navigation tasks during the next several minutes except for maintaining the LM plus Z-axis coarsely aligned with the CSM using radar error needles or the COAS. This time will be spent making systems checks and accomplishing test objectives.

Final computation of TPI_o is accomplished 14 minutes prior to ignition. The TPI_o solution is evaluated and the onboard GO, NO GO decision is made about 94:51.

2.5 L.U Alignment and Close Approach to CSM

If the insertion maneuver is to be executed, the rendezvous radar antenna is driven from the AOT field of view and is turned off so that it will not drift back into the field of view. A REFSMMAT alignment (Program 52) is then accomplished between 94:50 and 95:08. After completion of the alignment, the rendezvous radar is turned on and an automatic radar lock on is performed in preparation for monitoring the close approach to the CSM (about 2.8rm). The inertial angular rate of the line of sight to the CSM is also monitored to insure that the trajectory is not intercepting.

6 Insertion Maneuver

When the radar indicates the range is increasing, PGNS External Delta V (Program 30) is loaded with the parameters of the insertion burn and the event timer is set counting down. The AGS is updated, aligned, and targeted in external delta V prior to the maneuver.

DPS Thrusting (Program 40) is called and the auto maneuver under PGNS control to the burn attitude is enabled. This burn is executed under automatic PGNS control with AGS monitoring.

2.7 CSI Maneuver

At about 95:49, CSI targeting is accomplished using Program 32 and AGS. Some iteration on the CDH apsis (1st or 2nd) may be required to obtain a solution from both PGNS and AGS. Prestaging checks are begun at about CSI -5 minutes to insure readiness to stage just prior to CSI. Radar updating is terminated 14 minutes prior to CSI and the final solution computed. This solution is recorded and transmitted to the ground and CSM. A CSI chart solution is calculated to validate the "G" mission procedures. The AGS is updated, aligned, and targeted in external delta V with the CSI solution to be burned. An automatic maneuver to the thrusting attitude is done under PGNS control (Program 41) and last minute prestaging systems checks are accomplished. The descent stage is jettisoned at ignition. RCS thrusting is started on time, and ascent fuel is used through the interconnect system to supplement RCS fuel usage.

.8

CDH Maneuver

Program 33 is selected after the CSI burn and the AGS absolute time of CDH is loaded from the PGNS. The LGC is updated with radar marks as in other prethrust sequences, and a solution is computed. A CDH chart solution is calculated 7 minutes prior to TIG. The AGS is updated, aligned, and targeted in external delta V with the CDH solution to be burned. An automatic maneuver to the thrust attitude is performed, and CDH thrusting is done with the Ascent Propulsion System (APS) using Program 42.

2.9 TPI Maneuver

Radar tracking is initiated after the CDH maneuver and updating of the LGC continued. Terminal Phase targeting is done in Program 34, and in the AGS. Radar updates are entered into the AGS, taking marks approximately every three minutes. Both systems are targeted to have a node occur at intercept. Backup measurements are made at the appropriate times. The AGS is aligned, updated, and retargeted in external delta V mode with the solution to be used for TPI. The TPI maneuver is accomplished in attitude hold, using RCS thrusting along the plus Z-axis with the thrust direction established with the COAS.

.10 Midcourse Corrections (MCC)

The midcourse program (Program 35) is assumed to have ATIGINC =3 minutes. (ATIGINC is the constant that determines time between selecting final computation cycle and the midcourse maneuver time).

MCC 1

Program 35 is entered immediately after TPI, and radar track reinitiated. Backup measurements are made and MCC chart solutions obtained.

MCC 1 is made to occur at TPI plus 10 minutes in the PGNS by proceeding from display "Verb 16 Noun 45" at TPI plus 7 minutes. The backup solution is valid for TPI plus 10 minutes.

If MCC 1 is to be executed, Program 41 is selected to burn the components with RCS. No maneuver to a "preferred" thrust attitude will be made. (LM plus Z-axis will remain pointed at the CSM after TPI until docking.)

MCC 2

MCC 2 occurs at TPI plus 22 minutes by keying STBY at TPI plus 19 minutes. A backup chart solution is obtained at TPI plus 20 minutes. The maneuver is executed as MCC 1.

2.11 Braking

In preparation for braking, the DAP is checked to verify narrow deadband is selected. Program 20 is terminated at 18,000 ft but the radar is kept in AUTO TRACK to provide radar range and range rate displayed on the tape meter. Average "G" is turned on prior to braking, and attitude hold is selected. The braking schedule is followed as contained in section 3.

3.0 Nominal Mission Procedures

The procedures included in this section do not specify which crewmember, Commander or LM Pilot, performs each listed task. These need not be specified since the following basic rules define which crewmember performs each task. These rules are:

COMMANDER (CDR):

1. All attitude changes, whether manual or automatic, will be accomplished by the CDR.
2. The operation of the DSKY during thrust programs (P40, P41, P42, P47) will be done by the CDR. Actual manipulation of the Translation Thrust Control Assembly (TTCA) need not be always done by the CDR, but in most cases will be.
3. Operation of the rendezvous and landing radar will be done by the CDR.
4. The CDR will operate all other systems accessible to only his crew station.

LM PILOT (LMP) TASKS:

- .. AGS operation.
- 2. DSKY operation will be done by the LMP except when keyboard entries affect the control of spacecraft attitude or thrusting.
- 3. Backup data logging and chart calculations.
- 4. All logging of maneuver solutions and systems performance.
- 5. The LMP will operate all other systems accessible to only his crew station.

These general rules are guidelines only, and may be deviated from by the LM crew if they develop more efficient Task assignments.

The abbreviations used herein are consistent with those in the AOH. However, in order to condense and simplify the procedures so that they are representative of onboard data, a number of additional shorthand conventions have been used. To allow the unfamiliar reader to understand the procedures contained in this section, the following explanations are included:

1. AGS - A single asterisk is employed to denote those procedures involving operations to be performed on the DEDA. The three number group following an asterisk specifies DEDA address. An "R" following the address group indicates the address is to be read out. A five digit group behind the "R" indicates a nominal or expected display. If the three number address group is followed by a + or - sign, a data load is indicated. When a single digit follows the +, addition of 4 zeros behind this digit is assumed. Once used, these conventions are easily handled and save considerable space.

2. PGNS - The verb-noun addresses in the PGNS are indicated to the left of the procedures column. An "F" is used to indicate a flashing display, or absence of an "F" a static display. To the right of the verb-noun, on the same line, are the contents of the three data registers. If numeric quantities appear, the DSKY should be correspondingly made to agree by executing a V21, V22, or V23 and performing a data load. The procedure of blanking and loading registers is not included since it is repeated often and is highly familiar to the crews.

EXAMPLE: F 06 33 94:39:46 TIG DPS SEP

Expanded, this means; Load flashing verb 06 noun 33 with the quantity 94 hours, 39 minutes and 46 seconds; the time of ignition of the descent engine separation maneuver.

Procedurally, this is done by keying verb 25 enter, loading +00094 in register 1, +00039 in register 2, and +04500 in register 3.

If numeric quantities do not follow the verb-noun, it is indicated that a computed or information quantity is being displayed via the DSKY. If nominal values are listed for possible comparison, they appear in parentheses.

EXAMPLE: F 06 42 HA HP ΔV

Expanded, this means; Flashing verb 06 noun 42 has computed height of apogee in register 1, height of perigee in register 2, and velocity to be gained in register 3.

TIME - The numbers in the left hand column preceded by a + or - indicate "event timer" time referenced to an event.

Minus indicates event timer counting down to a future event.

Periodically, this same column contains the nominal mission ground elapsed times (G.E.T.) in parentheses. Asterisks following the event time indicate a time critical event which should be accomplished to the nearest second.

ASSUMPTIONS

- 1 TRANSFER COMPLETE
- 2 SYSTEMS CHECKS COMPLETE
- 3 PGNS ACTIVATED
- 4 AGS BN AND SELF TESTED
- 5 RCS PRESSURIZATION AND TEST FIRING COMPLETE
- 6 RNDZ RDR SELF TEST COMPLETE.
- 7 DAP LOAD (01002)
- 8 IMU ALLIGNED
- 9 LGC IN PGNS
- 10 V76E (PGNS PULSE)

(92:41)

WHEN CLEAR OF CSM
 GUID CNT-AGS
 DEFLECT ACA BUT OF DETENT
 ATT CNT-MODE CNT(3)
 YAW RIGHT 120DEG (RATE CMD)
 PITCH UP 180 DEG (2 DEG/SEC
 (CSM PHOT0 OF DPS BELL)
 PITCH DN 90 DEG (2 DEG/SEC)
 (CSM IN FWD WINDSW)

(92:49)

ATT CNT(YAW)=PULSE
 YAW 360 DEG FOR INSPECTION
 (APPROX 1 DEG/SEC)

GUID CNT-AGS
 MODE SEL-LDG RADAR
 RNG/ALT MN-RNG/RNGRT
 RATE ERR MN-RNDZ RDR (CDR)
 ATTITUDE MN-PGNS(CDR)
 RATE ERR MN-CMPTR(LMP)
 ATTITUDE MN-AGS(LMP)
 SHFT/TRUN=+50
 X-POINTER-HI MULT
 RADAR TEST SW-BFF
 ENG GMBL-ENABLE
 ENG ARM-BFF
 X-TRANSL-2JETS
 BAL CPL-BN
 DEADBAND-MIN
 ATT CNT-PULSE(3)
 MODE CNT-ATT HOLD
 THRBT/JET-JET
 IMU-BN
 R/R MODE-LGC
 TTCA/TRANSL(CDR)=ENABLE
 ACA/4JET(CDR)=ENABLE
 TTCA/TRANSL(LMP)=ENABLE
 ACA/4JET(LMP)=ENABLE

1.

AS-504/CSM-104/LM-3

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WHEN CLEAR OF CSM
 GUID CNT-AGS

ATT CNT(YAW)=MODE CNT
 KEY V77E (WHEN YAW=0)
 GUID CNT-AGS
 LM ACTIVE STA KEEP UNTIL
 AFTER CSM RCS SEP.
 GUID CNT-PGNS
 -7
 KEY V83E
 F 06 54 R,RDGT,THETA
 *304R THETA
 SET 0RDEAL
 PRB
 DSKY BLANKS
 ***** MINI-FOOTBALL *****
 KEY V84E (TGT AV)
 F 06 84 0AVX 0AVY +0005.0AVZ
 PRB
 F 06 33 93:05:45 TIG RCS SEPARATION
 2.

1/31/69

16 72 MONITOR SHIFT/TRUN ANGLES
(+00000TRUN +00000SHFT)
VERIFY DSKY WITH FDAI
KEY REL

(93:07) KEY V47E (AGS UPDATE)
F 06 16 GET 0F AGS 0 TIME
*414+1 UPDATE AGS
PRB
*414R (00000 COMPLETE)
F 50 16 D8WNLINK COMPLETE
PRB
(WAIT 32 SECONDS)
*400+3 AGS ALIGN
DSKY BLANKS

-57 KEY V63E
(PGNS MODE 2 ERR NEEDLES)

CB AC BUS A RNDZ RDR-CLOSE
(WAIT 30 SEC8NDS)
CB PGNS RNDZ RDR-CLOSE

(93:08) R/R CHECKOUT
B8RESIGHT BN CSM WITH C8AS.
TEST MONITOR RNDZ RDR-AGC
SHIFT/TRUN-+5
R/R MODE-LGC
*507+0
*400+2 RADAR ACQUISITION

16 72 MONITOR SHIFT/TRUN ANGLES
(00000TRUN +283.00SHFT)
VERIFY DSKY WITH FDAI

KEY V83E
VERIFY R/R LOCKON 6800
F 06 54 READ R,RD8T,THETA
PRB
KEY V62E
F 04 06 00004 00001
PRB
F 16 72 +XXX.XX +XXX.XX
PRB
F 16 78 XXXXX.XR XXXXX.XRD8T
VERIFY TAPE METER WITH DSKY
KEY V34E (TERMINATE)

(MANUALLY BREAK LOCK)
R/R MODE-SLEW
SLEW RATE SW-L8
(SLEW D8MN 30 DEG.)
R/R MODE-LGC

KEY V41N72E (R/R DESIGNATE)
F 21 73 +000.00TRUN -07.00SHFT
F 04 06 00006 00002
PRB
41 (COARSE ALIGN VERB)
KEY V16N72E
16 72 MONITOR SHIFT/TRUN ANGLES
(000.00TRUN +283.00SHFT)
VERIFY DSKY WITH FDAI

AS-504/ESM-104/LM-3
PREPARED BY EPRB/CE24
1/31/68
3.
4.

CB AC BUS A RNDZ RDR=OPEN

***** PHASING *****
MANEUVER WITH RCS PULSES
F 54 71 AND MARK 1ST STAR
PRB

KEY V44E
KEY V37E30E (EXT AV)
F 06 33 93:50:04 TIG DPS PHASING
PRB
F 06 82 0AVX 0AVY -00085.0AVZ
PRB
F 06 42 HA HP AV
PRB
F 16 45 0 TFI MGA
-36 SET ET 10 DPS PHASING
PRB
F 37 BB
(93:18) KEY 52E (ALIGN)
F 04 06 00001 00003 (REFSMMAT)
PRB
F 50 25 00015 SELECT STAR 1
CB A&T LAMP-CLOSED
ENTR
-34 F 01 70 002DE LOAD STAR 1
PRB
F 50 18 FDAI ANGLES (R60)
M8DE C9NT-AUTB
PRB (AUTB MAN)
06 18
F 50 19 FDAI ANGLES TRIM MANEUVER
PRB (TRIM NOT REQD)
F 01 71 002DE
PRB
F 01 70 002DE LOAD 2ND STAR
PRB
F 50 18 FDAI ANGLES
M8DE C9NT-AUTB
PRB (AUTB MAN)
06 18
F 50 19 FDAI ANGLES TRIM MANEUVER
PRB (TRIM NOT REQD)
-27 F 01 71 002DE
PRB
M8DE C9NT-ATT HOLD
MANEUVER WITH PGNS PULSES
F 54 71 AND MARK 2ND STAR
PRB (MARKS COMPLETE)
F 06 05 ANGLE DIFFERENCE
PRB
F 06 93 GYR6 TORQUE ANGLES (XX-XXX)
PRB
***** BEYOND THIS POINT
ACCOMPLISH COAS CALIBRATION
ION TO THE EXTENT POSSIBLE
BY TIG MINUS 14.

F 50 25 CC014
PRB (COAS CALIBRATION)
F 50 25 00015 SELECT STAR 1
ENTR
5.
6.
AS-504/CSM-104/LM-3
PREPARED BY FPRB/CF24
1/31/69

PRB
 F 50 18 FDAI ANGLES (R60)
 MODE CNT-AUTB
 PRB (AUTO MANEUVER)
 F 06 18 FDAI ANGLES
 PRB (TRIM NOT REQD)
 F 50 19 FDAI ANGLES TRIM MANEUVER
 PRB

F 04 10 UUUUJ UUUUJ
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 F 06 18 FDAI ANGLES
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 F 50 18 FDAI ANGLES
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 F 06 18 FDAI ANGLES
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 F 50 19 FDAI ANGLES TRIM MANEUVER
 PRB

*18 F 01 71 005DE
 OBSERVE STAR IN CSM, WHEN
 ATTITUDE ERRORS ARE ZERO
 MARK AZ-EL ANGLE ON CSM
 DIAGRAM.
 -7

PRB
 F 06 87 AZ-EL CALIB ANGLES
 PRB
 KEY V34E (TERMINATE)
 CB A9T LAMP-OPEN
 KEY V37E88E

KEY V47E (AGS UPDATE)
 F 06 16 GET 9F AGS 0 TIME
 *414+1 UPDATE AGS
 PRB
 *414R (00000 COMPLETE)
 F 50 16 DOWNLINK COMPLETE
 PRB
 (WAIT 32 SECONDS)
 *400+3 AGS ALIGN
 *411+0 DPS ENG SELECT
 *400+1 GUIDANCE STEERING

CB AC BUS A RNDZ RDR-CLOSE
 (WAIT 30 SECONDS)

CB PGNS LR-CLOSE
 R/R MODE-SLEW
 NB TRK LT-BN
 KEY V76 (PGNS PULSE)
 MODE CNT-ATT HOLD
 BORESIGHT ON CSM WITH CSM.
 (PGNS PULSE MODE)
 SLEW RADAR NEEDLES TO (0,0)
 MAX SIGNAL STRENGTH.
 R/R MODE-AUTB TRACK
 NB TRK LT-BUT
 RATE ERR M9N-LDG RDR/CMPTR

(93:46)
 KEY V37E40E (DPS THRUSTING)
 F 50 18 FDAI ANGLES
 MODE CNT-ATT HOLD
 ENTR (MANUAL MANEUVER)
 F 50 19 FDAI ANGLES TRIM MANEUVER
 -3
 KEY V06N86E (AV'S LV)
 L8AD AGS EXT AV
 *410+5 EXT AV
 *450+00001AVX 451+0AVY
 *452-00085AVZ LOAD
 SOLUTION IN AGS.

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COMPLETE.
KEY RELEASE
KEY V78E (LR SPUR TEST)

THR_T/JETS (CDR)-THR_T

THR_T(CDR)-SET MIN THRUST
ENG GMBL-0FF

THR CNT SW-MAN

MAN THR_T-CDR

X-TRANSL-2JETS

ENG ARM-DES

ATT CNT-PULSE (3)

MODE CNT-AUTO

GUID CNT-AGS

KEY V77E (ATT HOLD)

PRB (BYPASS TRIM)

F 50 25 00203 (AUTO THR_T REQUEST)

ENTR (AUT_T NOT DESIRED)

06 40 TF1 VG ⁴VM

500R00085 ⁴VM

DEADBAND-MIN (CBNFIRM)
(WHEN ERRORS ARE 0.)
TRIM AGS ERRORS TO 0.
ATT CNT-MODE CNT(3)

*:35 DSKY BLANKS

START ET COUNTING UP AT 0

-:08 COMMAND ⁴X TRANSLATION
WITH TTCA.

F 99 40 REQUEST ENG ON
ENG GMBL-ENABLE

0(93:50:04) ABORT-DEPRESS (ENG 0N)
ENTR (BYPASS PGNS ENG 0N)
F 16 40 TFC VG ⁴VM
MONITOR THRUST INDICATOR

9.

AS-504/CSM-104/LM-3

PREPARED BY FPRB/CF24

(AFTER 15 SEC ENG 0N)

CAUTION: BE PREPARED TO DEPRESS ENG
STOP IN EVENT LATE CUTOFF.

MODE CNT-ATT HOLD
ABORT-RESET
ENG ARM-0FF
PRB

F 16 85 ⁴VS-BODY
NULL AV'S WITH RCS
*500R 501R 502R (COPY)
GUID CNT-PGNS
KEY V76E
RATE ERR MON-RNDZ RADAR
PRB

F 37 88
KEY V79E (TERMINATE SPUR)
KEY 00E

CB PGNS LR-BOPEN

***** TP10 TP10 TP10 *****

IF PGNS FAILURE OCCURS
BETWEEN 93:50 AND 94:45,
SEE APPENDIX 1 FOR ABORT

R/R MODE- ⁴GC
KEY V95E (NG UPDATE)
KEY V37E20E (R>19,000FT)
F 50 18 FDI ANGLES
ENTR (MANUAL MANEUVER)

10.

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KEY V80E (UPDATE LM SV)
 F 05 09 00525 (POSSIBLE ALARM)
 PRB
 F 06 05 4THETA B B(AFTER ALARM)
 PRB (ACCEPT ANGLE DATA)
 (93:58) KEY V37E34E (TPIC)
 F 06 37 95:00:00 TIG @F TPI@
 PRB
 F 06 55 B +027.50 +130.0C
 PRB
 F 16 45 MKS TFI -00001
 (94:03) WHEN MARKS = 5, RECYCLE.
 +15(APPRBX) KEY V32E RECYCLE
 F 06 37 TIG @F TPI
 F 06 58 HP AVTPI AVTPF (COPY)
 PRB
 +18 MARKS RESUME
 F 06 59 AV'S-LDS (COPY)
 PRB
 F 16 45 MKS TFI -00001
 *410+3 TPI SEARCH
 *311-332.50 AT TRANS
 *313+050.00 AT TPI
 *410+4 (WHEN TFI = 50.00)
 *303R THETA AT TPI(027.50)
 *267R AV TPI (COMPARE PGNS)
 *371R AV TOTAL
 PRB (FINAL C6 P CYCLE)
 F 06 37 TIG @F TPI
 (94:16) PERFORM LR SELF TEST
 CB PGNS LR-CLOSE
 FOR LOADING IN P34.
 +26 TRANSMIT TIG @F TPI TO CSM
 PREPARED BY FPRB/CF24
 AS-504/CSM-104/LM-3
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NAVAN 1031 3000Z
 LDG ANT SW-DES
 X-POINTERS (READ)
 •VZA =+200FPS(PEGGED UP)
 •VYA =+200FPS(PEGGED RT)
 ALT/ALT RATE METER (READ)
 •ALT =8263FT (NOM)
 LDG ANT SW-HAVER
 ALT/ALT RATE METER (READ)
 •ALT =7981FT
 •ALT RT =449FPS
 SET RADAR TEST MONITOR TO:
 •ALT XMTR =3.5V
 •VEL XMTR =3.78V

KEY V62E
 F 04 06 00004 00002
 PRB
 F 16 66 08280FT ANT POS(00001)
 F 16 67 VXA=-00247, VYA=+00929,
 VZA=+00665FPS
 KEY V37E00E

LDG ANT SW-AUTO
 KEY V61E
 (WAIT 24 SECONDS)

KEY V62E
 F 04 06 00004 00002
 PRB
 F 16 66 08280FT ANT POS(00002)

KEY V37E00E

LDG ANT SW-DES
 (WAIT 10 SECONDS)
 LDG ANT SW-AUTO
 RADAR TEST SW=0FF

CB PGNS LR=OPEN

KEY V37E20E
 F 50 18 FDAI ANGLES
 ENTR (MANUAL MANEUVER)
 F 50 19 FDAI ANGLES TRIM MANEUVER
 PRB (TRIM NOT REQUIRED)
 DSKY BLANKS
 VERIFY R/R LOCKON GOOD
 (94:28) KEY V37E34E (TP10 FINAL)
 F 06 37 95:00:00 TIG OF TP10
 PRB
 F 06 55 B+027.50 E +130.00
 PRB
 F 16 45 MKS TFI -00001
 KEY V76E (PGNS PULSE)
 MODE CONT-ATT HOLD
 RECEIVE GO FROM GROUND
 WHEN MARKS = 4, RECYCLE.
 KEY V93E (REINIT W MATRIX)
 KEY V32E RECYCLE
 F 06 37 TIG OF TP1 (COPY)
 PRB
 F 06 58 HP AVTP1 AVTPF (COPY)
 PRB
 F 06 59 AV'S-L0S (COPY)
 PRB
 F 16 45 MKS TFI -00001
 *26 SET ET COUNTING DOWN
 WHEN MARKS = 6, RECYCLE.
 -20(APPROX) KEY V32E RECYCLE
 F 06 37 TIG OF TP1 (COPY)
 PRB
 F 06 58 HP AVTP1 AVTPF (COPY)
 PRB
 F 06 59 AV'S-L0S (COPY)

13.

AS-504/CSM-104/LM-3

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*410+3 TPI SEARCH ROUTINE
 *311+032.50 AT TRANS
 *313+C16.00 TFI TPI
 *410+4 (WHEN ET=-16)
 *303R THETA AT TPI
 *267R AV TPI (COMPARE PGNS)
 *371R AV TOTAL
 COPY GND TPI SOLUTION

-14 F 06 37 PRB (FINAL COMP CYCLE)
 TIG TPI
 TRANSMIT TIG OF TPI TO CSM
 FOR LOADING IN P34.

PRB
 F 06 58 HP AVTPI AVTPF
 PRB
 F 06 81 AV'S-LV

PRB
 F 06 59 AV'S-LOS
 PRB
 F 16 45 MKS TFI MGA

-10 RESET ET (IF REQD)
 PRB
 F 37 BB

(94:51) KEY 00E (POO)
 ON BOARD GO,NO GO

F 06 16 KEY V47E (AGS UPDATE)
 GET OF AGS O TIME
 *414+1 UPDATE AGS
 PRB

-9 KEY V41N72E (R/R DESIGNATE)
 F 21 73 +000.00TRUN -077.00SHFT
 F 04 06 00006 00002 CONTINJUS

PRB
 41 (COARSE ALIGN VERB)
 KEY V16N72E
 16 72 MONITOR SHFT/TRUN ANGLES
 (000.00TRUN +283.00SHFT)

CB PGNS RNDZ RDR=OPEN
 CB AC BUS A RNDZ RDR=OPEN

(94:52) KEY V37E52E (ALIGN)
 F 04 06 00001 00003 (REFSMMAT)

PRB
 F 50 25 00015 SELECT STAR 1
 CB AT LAMP=CLOSED
 ENTR

-7 F 01 70 002DE LOAD STAR 1
 PRB
 F 50 18 FDAI ANGLES
 MODE CONT=AUTO

16.

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15.

AS-504/CSM-104/LM-3

PRB (AUTO MANEUVER)
06 18 F0DA1 ANGLES TRIM MANEUVER
F 50 19 PRB (TRIM NOT RECD)

F 01 71 002DE
PRB
MODE CONT-ATT HOLD
MANEUVER WITH RCS PULSES
F 54 71 AND MARK 1ST STAR
PRB

-2 F 01 70 002DE LOAD 2ND STAR

F 50 18 F0DA1 ANGLES
MODE C0NT-AUT0
PRB (AUTO MANEUVER)

06 18 F0DA1 ANGLES TRIM MANEUVER
F 50 19 PRB (TRIM NOT RECD)

F 01 71 002DE
PRB
MODE CONT-ATT HOLD
MANEUVER WITH PGNS PULSES
F 54 71 AND MARK 2ND STAR

F 06 05 ANGLE DIFFERENCE

F 06 93 GYR0 TORQUE ANGLES
PRB

-57 F 50 25 00014

IF TIME PERMITS CHECK
ALIGNMENT WITH THIRD STAR

17.

ENTR (NO CHECK)
CB A0T LAMP-0 OPEN
F 37 BB

F 06 18 KEY V47E (AGS UPDATE)

F 06 16 GET OFF AGS 0 TIME
*414+1 UPDATE AGS

PRB
*414R (00000 COMPLETE)
F 50 16 D0WNLINK (00000
PRB

(WAIT 32 SECONDS)
*400+3 AGS ALIGN

***** INSERTION *****

CB AC BUS A RNDZ RDR=CLOSE
(WAIT 30 SECONDS)
CB PGNS RNDZ RDR=CLOSE

KEY V95E (NO UPDATE)
KEY V37E20E (ACQUIRE RADAR)

F 50 18 FDA1 ANGLES
MBDE C0NT-AUT0

PRB (AUT0 MANEUVER)

06 18 F 50 19 FDA1 ANGLES TRIM MANEUVER
PRB (TRIM NOT REQUIRED)
MBDE C0NT-ATT HOLD

DSKY BLANKS

VERIFY R/R LOCKON GOOD
KEY V80E (UPDATE LM SV)

(95:20)
MONITOR RANGE ON TAPE METER
WHEN RANGE < 19,000FT
KEY V95E INHIBIT SV UPDATE

18.

AS-50A/CSM-104/LM-3

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KEY V37E30E (EXT AV)
F 06 33 95:41:48 TIG INSERTION
PR0
F 06 82 +0039.9AVX 0AVY CAVZ
PR0
F 06 42 HA HP AV
PR0
F 16 45 MKS TFI MGA

-18 RESET ET COUNTING DOWN
 WHEN MARKS = 6, PROCEED.
PR0
F 37 88

-8 KEY 00E (POO)
 KEY V47E (AGS UPDATE)
 F 06 16 GET OF AGS O TIME
 *414+1 UPDATE AGS
PR0
*414R (100000 COMPLETE)
F 50 16 DOWNLINK COMPLETE
PR0
(WAIT 32 SECONDS)
*400+3 AGS ALIGN
*411R 00000 (CONFIRM)
*400+1 GUIDANCE STEERING

-7 CB PGNS LR-CLOSE

(95:35) KEY V77E (ATT HOLD)
 KEY V37E40E
 MODE CNT-AUTO

19.

AS-504/CSM-104/LM-3

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KEY V40N00T (AV'S LV)
LOAD AGS EXT AV
*410+5 EXT AV
*450+00040AVX 451+04VY
*452+0AVZ
SOLUTION IN AGS.
KEY RELEASE
KEY V78E (LR SPUR TEST)
THR0T/JETS(CDR)-THR0T
THR0T(CDR)-SET MIN THRUST
THR C0NT SW-MAN
MAN THR0T-CDR
X-TRANSL-2JETS
ENG ARM-DES

-4 F 50 19 F041 ANGLES TRIM MANEUVER
 PRB (TRIM NOT REQD)
 *407+0 WHEN MANEUVER IS
 COMPLETE.
F 50 25 00203 (AUT0 THR0T REQUEST)
ENTR (AUT0 NOT DESIRED)
-3 06 40 TFI VG AVM
 *COMPARE AGS ATT ERRORS
 *500R+000040. AVX
*:35 DSKY BLANKS
*:8 MONITOR ULLAGE
 F 99 40 REQUEST ENG ON
 ENG GMBL-ENABLE
0(95:41:48) PR0 FOR ENG ON ENABLE
06 40 TFC VG AVM
MONITOR THRUST INDICATOR

CAUTION: BE PREPARED TO DEPRESS ENG
STOP IN EVENT LATE CUTOFF.

20.

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F 16 40 TFC VG AVH
ENG ARM-OFF
PRB
F 16 85 AVIS-BODY
NULL AVIS WITH RCS
THRBT/JETS(CDR)-JETS
KEY V79E (TERMINATE SPUR)
PRB

F 37 88

***** CSI CSI CSI *****
CB PGNS LR-OPEN

IF PGNS FAILURE OCCURS
BEYOND THIS POINT,
SEE APPENDIX 3 FOR ABORT

IF A RADAR FAILURE OCCURS,
LM TARGETS CSI AND CDH
WITH P30 AND EXECUTES
BURNS AS PER NORMAL PRB-
CERURES, CSM IS ACTIVE
FOR TPI AND TPF.

KEY V95E (NG UPDATE)
KEY V37E20E
F 50 18 FDAO ANGLES
MODE C0NT-AUT0
PRB (AUT0 MANEUVER)

F 50 19 FDAO ANGLES TRIM MANEUVER

DSKY BLANKS
VERIFY R/R LOCKON GOOD
KEY V80E (UPDATE LM SV)

(95:51) F 06 30 KEY V37E32E
PRB

FIRST APSIDAL XING.
F 06 55 +00001 N +027.50 E
PRB

F 06 37 98:02:21 TIG OF TPI
(WITH 3 MIN TIME BIAS)
PRB

F 16 45 MKS TFI -00001

*34 SET ET COUNTING DOWN

KEY V76E (PGNS PULSE)
M8DE C0NT-ATT HLD
COPY RD8T FROM TAPE METER
FOR BU'S

WHEN MARKS = 4, RECYCLE
KEY V93E (REINIT w MATRIX)

KEY V32E (RECYCLE)
F 06 50 4H AT-CSI/CDH AT-CDH/TPI
PRB

F 06 81 AVIS-LV(CSI) (C8FY)
PRB

F 06 82 AVIS-LV(CDH) (C8FY)
PRB

F 16 45 MKS TFI -00001
NOTE: MANUAL ITERATION FOR FINDING
THE PROPER APSIDAL XING MAY BE REQD
WHEN MARKS = 4, RECYCLE.

21.

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22.

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F 06 82 **AVIS-LV(CDH) (COMPARE)**
 PRB
 F 16 45 MKS TFI -00001
 WHEN RANGE IS > 50.8 NM.
 KEY V37E00E (P00)
 KEY V62E
 F 04 06 00004 00001
 PRB
 F 16 72 +XXX.XX +XXX.XX
 PRB
 F 16 78 XXXXX.XR XXXXX.XR06T
 VERIFY TAPE METER WITH DSKY
 KEY V37E00E

 F 50 18 FDAO ANGLES
 MODE CNT-AUTO
 PRB (AUTO MANEUVER)
 06 18
 F 50 19 FDAO ANGLES TRIM MANEUVER
 PRB (TRIM NOT REQUIRED)
 DSKY BLANKS
 VERIFY R/R LOCKON GOOD

 KEY V37E20E
 PRB
 FIRST APSIDAL XING.
 F 06 55 +00001 N +027.50 E
 PRB
 F 06 37 98:02:21 TIG OF TPI
 (WITH 3 MIN TIME BIAS)
 PRB
 F 16 45 MKS TFI -00001

(96:04) *277+479.3 AGS TPI TIME
 *605+10250 TPI ANGLE CODE
 *416+0 1ST APSIDAL
 *417+1
 *410+1 CSI ROUTINE
 *457R CHECK < 2FPS
 *463R ALT RATE (COPY)
 *313R TFI CSI
 COMPARE 313 WITH E.T.
 *456R AVCSI COPY
 *371R AVCDH COPY
 *276R ABS TIME CDH(0426.5)
 *411+0 RCS ENGINE
 *450R AVX 452R AVZ

 KEY V48E (DAP LOAD)
 F 01 46 DAP CONFIGURATION (020002)
 PRB
 F 06 47 LM WT CSM WT
 KEY V34E (TERMINATE)
 F 16 45 MKS TFI -00001
 -14 F 06 50 AH AT=CSI/CDH AT=CDH/TPI

 PRB
 F 06 81 AVIS-LV(CSI) (COPY)
 -12 F 06 16 LOAD CSI TIME
 PRB
 F 06 90 Y, YDBT, PSI
 (COPY YDBT AT CSI)
 PRB

23.

AS-504/CSM-104/LM-3

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24.

2 FPS, LOAD •YDGT IN R2.
•10• COPY RANGE AND RDGT FROM
TAPEMETER FOR BU'S

450, 451, 452 LOAD THE
COMPONENTS OF SOLUTION
TO BE EXECUTED.
KEY RELEASE

F 06 82 AV'S-LV(CDH) (CBPY)
PRB
PRB

F 16 45 MKS TFI MGA
PRB

F 37 BB KEY OOE (POO)
PRB

PERFORM PRESTAGE CHECKS.
COMPARE AGS AND PGNS
CBOARD SOLUTION WITH GND
TRANSMIT TGT AV'S TO CSM
AND SYNC COUNTDOWN.

(96:15) KEY V47E (AGS UPDATE)
F 06 16 GET OF AGS 0.
*414+1 UPDATE AGS SV
PRB

*414R (10000 COMPLETE)
PRB
(WAIT 32 SECONDS)

*400+3 AGS ALIGN
*400+1 GUIDANCE STEERING

KEY V77E (ATT HOLD)

KEY V37E41E
F 50 18 FDAT ANGLES
MODE CNT-AUTO
PRB (AUTO MANEUVER)

06 18

KEY V06N86E (AV'S LV)
LOAD AGS EXT AV
PRB

25.

AS=504/CSM=104/LM=3

*3 F 50 19 BYPASS TRIM

PRB (TRIM NOT RECD)

*407+0 WHEN MANEUVER IS
COMPLETE.

ED: MASTER ARM=AN
THRBT/JET(CDR)=JET
X=TRANSL=4JETS

16 85 AV'S-BODY

*COMPARE AGS ATT ERRORS
*500R AVX (COMPARE)

*35 DSKY BLANKS

F 16 85

*0 STAGE SW-FIRE
ED: MASTER ARM SW=0FF

NOMINAL (37°8AVX)
(96:22:00) BURN +X WITH TTCA

ASC FEED 2-BOPEN (SYS A-B)
CHECK ASC FUEL AND BXID
FLAGS OPEN. (SYS A-B)

MAIN SV (SYS A AND B)=CLOS
MAIN SV (SYS A AND B)=OPEN
(BEFORE THRUST TERMINATION)
ASC FEED 2-CLOSE (SYS A-B)
(BEFORE THRUST TERMINATION)
NULL REMAINING AV'S
*500R AVX 501RAVY 502RAVZ

PRB
F 37 BB

26.

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(96:26) KEY V37E20E
 F 50 18 FDAI ANGLES
 MODE C9NT-AUTO
 PR0 (AUTO MANEUVER)
 06 18 KEY V37E33E (CDH)
 PR0 (TRIM NOT REQUIRED)
 DSKY BLANKS
 VERIFY R/R LOCKON GOOD
 KEY V80E (UPDATE LM SV)
 (96:29) KEY V76E (PGNS PULSE)
 MODE C9NT-AT: HOLD
 *54 F 06 31 KEY V37E33E (CDH)
 TIG 9F CDH (97:06:28)
 KEY V25E
 (ADD 1 MIN 45 SEC BIAS)
 PR0
 F 16 45 MKS TFI -00001
 *37 SET ET T0 TFI CDH
 (96:30) WHEN MARKS = 4, RECYCLE
 KEY V93E (REINIT W MATRIX)
 -35(APPROX) KEY V32E RECYCLE
 F 06 50 MKCDH ATCDH/TPI ATTPI/TPI
 PR0
 F 06 81 AVCDH-LV (COPY)
 PR0
 F 16 45 MKS TFI -00001
 *410+2 CDH R0UTINE
 *276+ABS TIG CDH (426.5)
 (PG'S COMPUTED TIG CDH)
 *267R AV CDH (COPY)
 18 COPY R0UT FROM TAPE METER
 FOR BU'S
 *14 PR0 (FINAL COMP CYCLE)
 F 06 50 MKCDH ATCDH/TPI ATTPI/TPI
 PR0
 F 06 81 AV-S-LV (COPY)
 *12 KEY V90E
 F 06 16 LOAD CDH TIME
 PR0
 F 06 90 Y'YD0T,PSI
 (COPY Y AND YD0T AT CDH)
 PR0
 F 16 45 MKS TFI -00001
 !IF YD0T FROM V90 WAS > THAN
 2 FPS, LOAD *YD0T IN R2.
 PR0
 F 16 45 MKS TFI MGA
 PR0
 F 37 BB KEY 00E (POO)
 C0B0D SOLUTION WITH GND
 TRANSMIT TGT AV'S TO CSM
 AND SYNC COUNTDOWN.
 (96:57) KEY V47E (AGS UPDATE)
 F 06 16 GET OF AGS 0
 *414+1 UPDATE AGS
 PR0
 *414R (00000 COMPLETE)

27.

28.

AS-504/CSM-104/LM-3

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F 06 55 B +027.50 E +130.00
PRB
F 16 45 MKS TFI -00001

KEY V76E (PGNS PULSE)
MODE CANT-ATT HOLD

(97:18) WHEN MARKS = 4, RECYCLE.

KEY V93E (REINIT W MATRIX)
-42(APPRBX)
KEY V32E RECYCLE
F 06 37 TIG 9F TPI (C8PY)
PRB

F 06 58 HP AVTPI AVTPF (C8PY)

F 06 59 AVIS-L9S (C8PY)

F 16 45 MKS TFI -00001
PRB

-38 SET ET COUNTING DOWN

*415+1 316+R
*415+1 316+R

WHEN MARKS = 6, RECYCLE.

-33(APPRBX) KEY V32E RECYCLE
F 06 37 TIG 6F TPI (C8PY)
PRB

F 06 58 HP AVTPI AVTPF (C8PY)

F 06 59 AVIS-L9S (C8PY)

F 16 45 MKS TFI -00001
PRB

*404+0 405+0 406+0
*411+1 RCS THRUST
*415+1 316+R

-32

31.

AS-504/CSM-104/LM-3

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*415+1 316+R
*267R AV TPI (COMPARE PGNS)
*371R AV TOTAL

C8PY GND TPI SOLUTION

WHEN MARKS = 12, RECYCLE.

-27(APPRBX) KEY V32E (RECYCLE)
F 06 37 TIG 6F TPI (C8PY)
PRB

F 06 58 HP AVTPI AVTPF (C8PY)

F 06 59 AVIS-L9S (C8PY)

F 16 45 MKS TFI -00001
PRB

*415+1 316+R
*415+1 316+R
*415+1 316+R

*415+1 316+R
*313+016.C0 TFI TPI
*410+4 (WHEN ET = 16)

*303R THETA AT TPI (C8PY)
*267R AV TPI (COMPARE PGNS)
*371R AV TOTAL (C8PY)

*415+1 316+R
*415+1 316+R
*415+1 316+R

*313+016.C0 TFI TPI
*410+4 (WHEN ET = 16)

*303R THETA AT TPI (C8PY)
*267R AV TPI (COMPARE PGNS)
*371R AV TOTAL (C8PY)

32.

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-3 KEY V06N86E (AV'S LV)
 LOAD AGS EXT AV
 *410*5 EXT AV
 *450, 451, 452*LOAD
 COMPONENTS OF SOLUTION
 TO BE EXECUTED.
 KEY RELEASE
 PRB

-2 F 50 19 FDAI ANGLES TRIM MANEUVER
 PRB (TRIM NOT REQD)
 *407*0 WHEN MANEUVER IS
 COMPLETE.
 16 85 AV'S BODY
 *500R AVX (COMPARE)
 *;35 DSKY BLANKS

F 16 85 AV'S BODY
 NOMINAL (21.8AVX)
 *0(97:59:21) BURN +Z WITH TTCA

+0:00 SET ET COUNTING UP
 NULL REMAINING AV'S
 *500R AVX 501RAVY 502RAVZ
 PRB

F 37 BB KEY OOE (P00)
 KEY V93E
 (REINITIALIZE W MATRIX)

***** 1ST MC CORRECTION *****

KEY V37E20E
 F 50 18 FDAI ANGLES
 ENTR (MANUAL MANEUVER)
 F 50 19 FDAI ANGLES TRIM MANEUVER
 PRB (TRIM NOT REQUIRED)

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99 RESET ET (IF REQD)

PRB

F 37 BB KEY OOE (P00)

(97:50) KEY V47E (AGS UPDATE)
 F 06 16 GET 9F AGS 0 TIME
 *414*1 UPDATE AGS
 PRB

F 50 16 DWNLINK COMPLETE
 PRB
 (WAIT 32 SECONDS)
 *400*3 AGS ALIGN

*304R COPY TGT LOS ANGLE
 COPY CSM SOLUTION FOR TPI
 COMPARE ONBOARD SOLUTIONS
 TRANSMIT TO CSM AND GND
 SOLUTION TO BE BURNED
 SYNC COUNTDOWN WITH CSM

*304R COPY TGT LOS ANGLE
 COPY R, RDBT FROM TAPE METER
 FOR BU'S.
 (97:55) CALCULATE BU SOLUTION
 KEY V77E
 KEY 41E
 F 50 18 FDAI ANGLES
 MODE CONT-ATT HOLD
 ENTR (MANUAL MANEUVER)

34.

(98:04) KEY V37E35E
F 16 45 MKS TFI -000001

5 *304R COPY TGT LOS ANGLE
*404+0 405+0 406+C
PR8 (C0MP MC F0R TPI +10)

+7 F 06 81 AV'S-LV (C0PY)
PR8
F 06 59 AV'S-LOS

*304R COPY THETA,R,RD9T

(98:09) COMPUTE BU MC CORRECTION

PR8
F 16 45 MKS TFI MGA
PR8
F 37 BB

IF 1ST MC SMALL, SKIP
P41 AND RECALL P35.

+9 KEY 41E
F 5C 18 FDAO ANGLES
ENTR (MANUAL MANEUVER)
F 50 19 BYPASS TRIM
PR8 (TRIM NOT REQD)
16 85 AV'S-BODY
COMPARE PGNS AND BU'S
KEY V77E

+9:25 DSKY BLANKS
+10 F 16 85 NULL AV'S WITH RCS
KEY V76E
PR8

35.

AS-504/CSM-104/LM-3

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+11 F 16 45 MKS TFI -000001
WHEN MARKS = 1, KEY V93E
(REINITIALIZE W MATRIX)

+17* *304R COPY TGT LOS ANGLE
*404+0 405+0 406+0
PR8 (C0MP MC F0R TPI +22)

*304R COPY THETA,R,RD9T
PR8
F 06 81 AV'S-LV (C0PY)
PR8
F 06 59 AV'S-LOS

PR8
F 16 45 MKS TFI MGA
PR8
F 37 BB

20 *304R COPY THETA,R,RD9T

(98:20) COMPUTE BU MC CORRECTION

KEY 41E
F 50 18 FDAO ANGLES
ENTR (MANUAL MANEUVER)
F 50 19 BYPASS TRIM
PR8 (TRIM NOT REQD)
16 85 AV'S-BODY
COMPARE PGNS AND BU'S
KEY V77E
+21:25 DSKY BLANKS

+22 F 16 85 NULL AV'S WITH RCS
KEY V76E

36.

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PR6

F 37 BB KEY 00E (P00)

KEY V37E47E (AVERAGE G)
BLANK FOR 1 MIN
F 16 83 AVIS

F 04 06 00004 00001
KEY V62E
PR6

F 16 72 +XXX.XX +XXX.XX
PR6

F 16 78 XXXXX.XR XXXXX.XRD9T
VERIFY TAPE METER WITH DSKY

(98:30) KEY V77E (AT H0:D)
BRAKING: 30FPS = 6000FT
20FPS = 3000FT
10FPS = 1500FT
5FPS = 500FT

RENDÉZVÉBÜS

DCK

37.

AS-504/CSM-104/LM-3

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38.

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4.0 Abort Procedures

Three specific abort procedures are defined in this document in addition to the abort provisions inherent in the Nominal Mission Procedures. Reference is made to these in the Nominal Mission Procedures as Appendices 1, 2, and 3. Appendix 1 contains the PGNS failure abort procedures for TPI₀ through TPF. Appendix 2 defines the complete Guidance and Navigation (G&N) procedures for executing TPI₀ through TPF when aborting for failures other than G&N. Appendix 3 contains procedures for completing the remainder of the mission following a PGNS malfunction after the insertion maneuver.

PHASING.

```

*304
*415+1 316+R
*415+1 316+R
*303R (MONITOR LOS ANGLE)
*415+1 316+R
*415+1 316+R
*415+1 316+R
*303R (+027.50)

ATT C9NT-PULSE(3)
*400+2 RADAR ACQUISITION
M0DE C9NT-AUTO
PULSE TO NULL AGS ERRORS
POINT Z-AXIS IN DIRECTION
SF CSM.
M0DE C9NT-ATT HLD
ATT C9NT-M0DE C9NT(3)
SLOW R/R ANT TG C.0 9N F0A1
VERIFY MAX SIGNAL STRENGTH
R/R M0DE-AUT9 TRACK
NA TRK LT-BFF
COMPARE R/R ERR NEEDLES
WITH C9AS, IF CSM VISIBLE.
ATT C9NT-PULSE(3)

***** TPIC TPIC TPIC *****

*410+3 TPI SEARCH ROUTINE
*311+032.50 AT TRANS
*313+040.00 TFI TPI
*303R LOS ANGLE IN 40 MIN
*410+4 (WHEN 303R=+027.50)
*313R TFI TPI

-40
SET ET COUNTING DOWN
*415+1 316+R
*415+1 316+R
*303R (+027.50)

*415+1 316+R
*415+1 316+R
*303R (IF TPI ANGLE HAS CHANGED)
(RETARGET AGS)
*410+3 TPI SEARCH
*313+013.00 TFI TPI
*303R LOS IN 13 MIN
*410+4 (WHEN 303R=+027.50)
*267R AV TPI (+00022.)
*371RAV TOTAL (+00050.)
COPY AGS SOLUTION THEN,
LOAD GROUND SOLUTION IN
EXTERNAL DELTA V
*304R COPY TGT LOS ANGLE
*304R COPY TGT LOS ANGLE
COPY R AND RD8T FROM TAPE
METER FOR BU'S
CALCULATE BU SOLUTION
*404+0 405+0 406+0
(IF BU'S BURNED, MONITOR AV
APPLIED WITH 470 471 472)
M0DE C9NT-AUTO
*400+2 Z-AXIS GUIDANCE
*507+ STEERING
PULSE TO NULL AGS ERRORS
ATT C9NT-M0DE C9NT(3)

40.

```

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SET ET COUNTING UP AT 0

***** 1ST MC CORRECTION *****

MCDE CANT-MODE HOLD (WHEN
*502 IS LESS THAN +15)
NULL REMAINING AV'S
*500RAVX 501RAVY 502RAVZ
ATT CANT-PULSE(3)

*304R COPY TGT LOS ANGLE

*304R COPY THETA,R,RDOT

CALCULATE BU MC CORRECTION

*404+C 405+0 4C6+C
(IF BU'S BURNED, MONITOR AV
APPLIED WITH 47C 471 472)
*400+0 ATT HOLD

***** 2ND MC CORRECTION *****

+10 ATT CANT-MODE CANT(3)
NULL AV'S WITH RCS
*500RAVX 501RAVY 502RAVZ
ATT CANT(3)-PULSE

*304R COPY TGT LOS ANGLE

*304R COPY THETA,R,RDOT

41.

AS-504/CSM-104/LM-3

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*22

ATT CANT-MODE CANT(3)
NULL AV'S WITH RCS
ATT CANT-PULSE(3)

*404+0 405+0 406+0
MONITOR BRAKING AV VIA 470,
471, AND 472.

BRAKING:

30FPS-6000FT
20FPS-3000FT
10FPS-1500FT
5FPS- 500FT

RENDIEZVOUS

DOCK

42.

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APPENDIX C FOR ALBKI
PERFORM PRESTAGE CHECKS

- *3 KEY V06N86E (AV'S LV)
LOAD AGS EXT AV
*410+5 EXT AV
*450, 451, 452=LOAD
COMPONENTS OF SOLUTION
TO BE EXECUTED.
KEY RELEASE
- *4 F 50 19 BYPASS TRIM
PRB (TRIM NOT REQD)
*407+0 WHEN MANEUVER IS
COMPLETE.
- *2 ED: MASTER ARM SW=ON
- *16 85 AVIS-BODY
*500R AVX (COMPARE)
- *35 DSKY BLANKS
- *8 STAGE SW=FIRE
ED: MASTER ARM SW=OFF
- *0 F 16 85
(94:59) BURN +Z WITH TTCA
+0:00 SET ET COUNTING UP
- *ULL REMAINING AVIS
*500RAVX 501RAVY 502RAVZ
PRB
- *4 F 37 BB
KEY 00E (P0E)
KEY V93E
(REINITIALIZE W MATRIX)
- *5 * * * * 1ST MC CORRECTION * * * * *
- *6 F 50 18 F01 ANGLES
KEY V77E
MODE C0NT-ATT HOLD
ENTR (MANUAL MANEUVER)
43.
- *7 44.

AS=504/CSM=104/LM=3

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F 50 19 BYPASS TRIM
PRB (TRIM NOT REQUIRED)
DISKY BLANKS
VERIFY R/R LOCKEN GOOD

F 16 45 MKS TFI -00001
KEY V37E35E

5 *304R COPY TGT LOS ANGLE

*404+0 405+0 406+C
PRB (COMP MC FOR TPI +10)
PRB
F 06 81 AV'S-LV (CPY)

F 06 59 AV'S-LOS

*304R COPY THETA,R,RD8.

COMPUTE BU MC CORRECTION

PRB
PRB
F 16 45 MKS TFI MGA

F 37 BB

IF 1ST MC SMALL, SKIP
F41 AND RECALL P35.

*9 F 50 18 FDAL ANGLES
ENTR (MANUAL MANEUVER)
F 50 19 BYPASS TRIM
PRB (TRIM NOT REQD)
16 85 AV'S-BODY
COMPARE PGNS AND BU'S
KEY V77E

WHEN MARKS = 1, KEY V93E.
(REINITIALIZE W MATRIX)
*304R COPY TGT LOS ANGLE
*404+0 405+0 406+0
PRB (COMP MC FOR TPI +22)
PRB
F 06 81 AV'S-LV (CPY)
PRB
F 06 59 AV'S-LOS
PRB
PRB
F 16 45 MKS TFI MGA
PRB
F 37 BB

20 *304R COPY THETA,R,RD8
COMPUTE BU MC CORRECTION

KEY 41E
F 50 18 FDAL ANGLES
ENTR (MANUAL MANEUVER)
F 50 19 BYPASS TRIM
PRB (TRIM NOT REQD)
16 85 AV'S-BODY
COMPARE PGNS AND BU'S
KEY V77E

45.

46.

AS-504/CSM-104/LM-3

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F 37 BB
PRB

***** 2ND MC CORRECTION *****

+11 F 16 45 KEY 35E
MKS TFI -00001

*404+0 405+0 406+C
PRB (COMP MC FOR TPI +10)

F 06 81 AV'S-LV (CPY)

*304R COPY THETA,R,RD8.
COMPUTE BU MC CORRECTION

PRB
PRB
F 16 45 MKS TFI MGA

F 37 BB

*304R COPY TGT LOS ANGLE
*404+0 405+0 406+0
PRB (COMP MC FOR TPI +22)
PRB
F 06 81 AV'S-LV (CPY)
PRB
F 06 59 AV'S-LOS
PRB
PRB
F 16 45 MKS TFI MGA
PRB
F 37 BB

20 *304R COPY THETA,R,RD8
COMPUTE BU MC CORRECTION

KEY 41E
F 50 18 FDAL ANGLES
ENTR (MANUAL MANEUVER)
F 50 19 BYPASS TRIM
PRB (TRIM NOT REQD)
16 85 AV'S-BODY
COMPARE PGNS AND BU'S
KEY V77E

46.

1/31/69

*21:25 DSKY BLANKS

*22 F 16 85 NULL AV C WITH RCS
KEY V76E
PRB

F 37 BB KEY 00E (P00)

KEY V37E47E (AVERAGE G)
BLANK FOR 1 MIN
AVIS

F 04 06 KEY V62E
00004 00001
PRB

F 16 72 XXXXX+XXX+XXX+XX
PRB

F 16 78 XXXXX+XR XXXXX+XRD8T
VERIFY TAPE METER WITH DSKY

KEY V77E (ATT HOLD)
BRAKING: 30FPS = 6000FT
20FPS = 3000FT
10FPS = 1500FT
5FPS = 500FT

RENDIEZVOUS

DCK

AS-504/CSM-104/LM-3

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47.

48.

(95:44)

CB AC BUS A RNDZ RDR=CLOSE
(WAIT 30 SECONDS)
CB PGNS RNDZ RDR=CLOSE

ATT CNT•PULSE (3)
R/R MODE•SLEW
*507+0
*400+2 RADAR ACQUISITION
RATE ERR MON=CMPTRL(MP)
PULSE TO NULL AGS ERRORS
PAINT Z-AXIS IN DIRECTION
OF CSM.
DEADBAND-MIN
MODE CNT•ATT HOLD
ATT CNT•MODE CNT (3)
RATE ERR MON=RNDZ RDR(CDR)
SLEW R/R ANT TO C.O. ON FDAI
VERIFY MAX SIGNAL STRENGTH
R/R MODE=AUTO TRACK
NG TRK LT=OFF
COMPARE R/R ERR NEEDLES
WITH CSM, IF CSM VISIBLE.
DEADBAND-MAX

***** CSI CSI CSI *****

*275+382.0 AGS CSI TIME
*277+479.3 AGS TPI TIME
*605+10250 TPI ANGLE CODE
*416+0.1ST APSIDAL
*417+1
*410+1 CSI RBTINE

SET 10 10 10 10

*456R AVCSI COPY
*371R AVCDH COPY
*276R ABS TIME CDH(0426.5)
*411+0 RCS ENGINE
*450R AVX 452R AVZ
COPY RDBT FROM TAPE METER
FBR BUIS
COPY RDBT FROM TAPE METER
FBR BUIS
COPY RANG. AND RDBT FROM
TAPEMETER FBR BUIS
PERFORM PRESTAGE CHECKS
ATT CNT•PULSE (3)
MODE CNT•AUTB
*411+0 RCS SELECT
*410+5 EXT AV
*450+AVX 451+AVY 452+AVZ
(LOAD GND CSI SOLUTION)
*10 *400+1 GUIDANCE STEERING
PULSE TO NULL AGS ERRORS
DEADBAND-MIN
TRIM AGS ERRORS
ATT CNT•MODE CNT (3)
*407+0 WHEN MANEUVER IS
COMPLETE.
*500RAVX
ED: MASTER ARM=ON

49.

50.

AS=504/CSM=104/LM=3

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ED: MASTER ARM=0FF
 SET ET COUNTING UP AT 0.
 •0(96:22) BURN +X WITH TTCA
 ASC FEED 2•OPEN(SYS A•B)
 CHECK ASC FUEL AND BXID
 FLAGS OPEN. (SYS A•B)
 MAIN 50V (SYS A•B)=CLOSE
 MAIN 50V (SYS A•B)=OPEN
 (BEFORE THRUST TERMINATION)
 ASC FEED 2•CLOSE (SYS A•B)
 (BEFORE THRUST TERMINATION)
 NULL REMAINING AV'S
 *500RAVX 501RAVY 502RAVZ

***** CDH CDH CDH *****

ATT CNT•PULSE(3)
 *400+2 RADAR ACQUISITION
 PULSE TO NULL AGS ERRORS
 POINT Z•AXIS IN DIRECTION
 8F CSM.
 MODE CNT•ATT HOLD
 ATT CNT•MODE CNT(3)
 SLEW R/R ANT TO C•O 9N FDA!
 VERIFY MAX SIGNAL STRENGTH
 R/R MODE=AUTO TRACK
 NB TRK LT•8FF
 DEADBAND•MAX

*410+2 CDH ROUTINE
 *276+0426+5 ABS TIME CDH
 *313R TFI CDH
 *411+1 APS SELECT

•37 SET ET T8 TFI CDH

51.

AS=504/CSM=104/LM=3

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*3/UKAV LUN

COPY GROUND SOLUTION

29 COPY RD8T FROM TAPE METER
 FOR BU'S
 18 COPY RD8T FROM TAPE METER
 FOR BU'S
 *263RAVY CDH 8PV COPY
 *450RAVX 452RAVZ COPY

COPY RD8T FROM TAPE METER
 FOR BU'S

CALCULATE BU CDH
 COMPARE SOLUTIONS

*410+5 EXT AV
 *450, 451, 452•LOAD
 GROUND SOLUTION FOR CDH.
 •5 ATT CNT•PULSE(3)
 *400+1 GUIDANCE STEERING
 MODE CNT=AUTO
 PULSE TO NULL AGS ERRORS
 DEADBAND-MIN
 TRIM ERRORS
 ATT CNT•MODE CNT(3)
 *407+0 WHEN MANEUVER IS
 COMPLETE.
 *500RAVX

*4 MONITOR ULLAGE
 •0(97:06:28) ABORT STAGE•DEPRESS

SET ET COUNTING UP AT 0.

52.

1/31/69

ABORT STAGE•RESET

$\lambda_S = 504 / (CSM = 104 / 14) = 3$

PREPARED BY FPRB/CF24

1/31/69

MODE C0NT-A/H WHEN 502<<5
NULL REMAINING ΔV 'S
*500R Δ VX 501R Δ VY 502R Δ VZ

*22

***** 1ST MC CORRECTION *****

ATT C0NT-PULSE (3)

*304R COPY TGT LOS ANGLE

*304R COPY THETA,R,ROBT

CALCULATE BU MC CORRECTION

*404+0 405+0 406+C
(IF BU'S BURNED, MONITOR ΔV
APPLIED WITH 47C 471 472)

*10

*400+0 ATT HBLD
ATT C0NT-M0DE C0NT (3)
NULL AV'S WITH RCS
*500R Δ VX 501R Δ VY 502R Δ VZ

ATT C0NT-PULSE (3)

***** 2ND MC CORRECTION *****

17 *304R COPY TGT LOS ANGLE

20 *304R COPY THETA,R,ROBT

CALCULATE BU MC CORRECTION

*404+0 405+0 406+C
(IF BU'S BURNED, MONITOR ΔV
APPLIED WITH 470 471 472)

55.

AS-504/CSM-104/LM-3

PREPARED BY FPRB/CF24

ATT C0NT-M0DE C0NT (3)
NULL AV'S WITH RCS
ATT C0NT-PULSE (3)

*404+0 405+0 406+C
MONITOR BRAKING ΔV VIA 470,
471, AND 472.

BRAKING:
30FPS=6000FT
20FPS=3000FT
10FPS=1500FT
5FPS= 500FT

RENDEZVOUS

DOCK

56.

1/31/69

5.0 Backup Charts

Backup chart solutions are calculated at CSI, CDH, TPI, MCC 1 and MCC 2. At CSI and CDH the charts are exercised as a validation of the F and G mission rendezvous procedures. At TPI and the midcourses they are second in priority to the LM PNGS solutions.

5.1 CSI Chart

The CSI chart solution is based on a Maclaurin's expansion of four variables for the delta V at CSI (range rate at 30, 20, and 10 minutes prior to CSI and range 10 minutes prior to CSI). The coefficients are determined by the simultaneous solution of several expansions, each representing a dispersed trajectory prior to CSI.

5.2 CDH Chart

The CDH chart solution utilizes the sinusoidal time history of range rate variations from coellipticity and relative velocity errors from coellipticity. Range rate data for the CDH chart are taken 29, 18, and 7 minutes prior to CDH.

5.3 TPI and MCC Charts

The TPI charts solve for the relative position and velocity at TPI resolved into normal and along the line-of-sight (LOS) coordinates. The measured relative state is differenced with the required state conditions for intercept in 130 degrees of orbit travel. Information required for the TPI charts is the elevation of the LOS from local horizontal (θ) at eight and five minutes prior to TPI, plus range and range rate five minutes prior to TPI. In a similar manner the midcourse charts maintain the time of TPF consistent with the TPI maneuver. Data are taken for the midcourses five and eight minutes after TPI for MCC 1 and 17 and 20 minutes after TPI for MCC 2. The same measurement sequence as used at TPI is used for both midcourse corrections.

CSI
BACK-UP TABLE
(NEXT PAGE)

87.	104.7	104.4
88.	105.9	105.0
89.	107.1	102.9
90.	108.3	103.0
91.	109.5	103.1
92.	110.7	103.2
93.	111.9	103.3
94.	113.1	101.1
95.	114.4	101.1
96.	115.6	101.1
97.	116.8	101.1
98.	118.0	101.4
99.	119.2	101.4
100.	120.4	101.4
101.	121.6	101.4
102.	122.8	102.4
103.	124.0	103.4
104.	125.2	104.4
105.	126.4	105.4
106.	127.6	106.4
107.	128.8	107.4
108.	130.0	108.4
109.	131.2	109.4
110.	132.4	110.4
111.	133.6	111.4
112.	134.8	112.4
113.	136.0	113.4
114.	137.2	114.4
115.	138.4	115.4
116.	139.6	116.4
117.	140.8	117.4
118.	142.0	118.4
119.	143.2	119.4

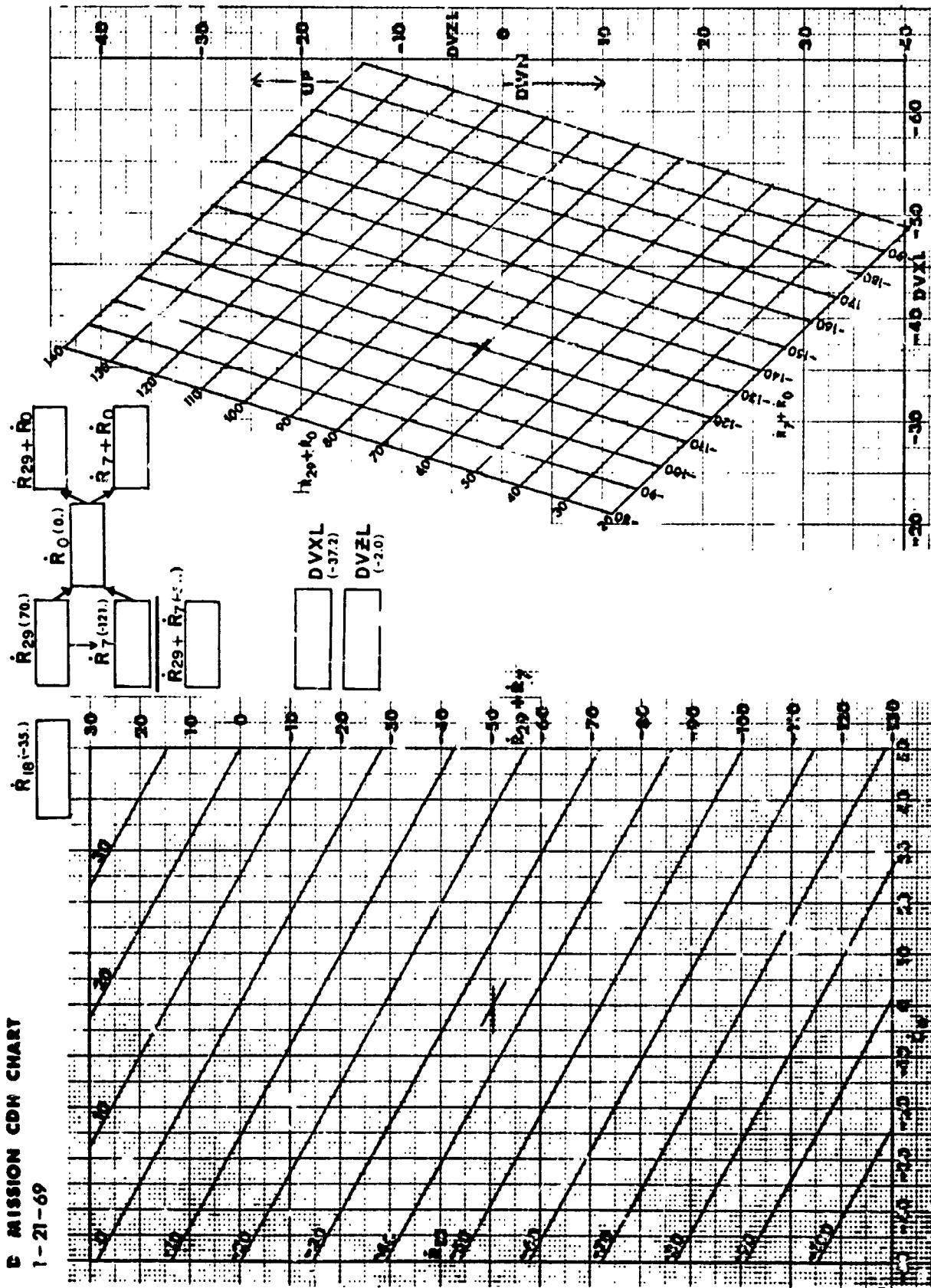
CSI BACK-UP TABLE: MISSION C

	\dot{R}_{30}	F_{30}	\dot{R}_{20}	F_{20}	\dot{R}_{10}	F_{10}	\dot{G}_{10}
120.	-100.4	120.	144.4	120.	-79.1	68.	-5.5
121.	-101.3	121.	145.6	121.	-79.8	69.	-5.6
122.	-102.1	122.	146.9	122.	-80.4	70.	-5.7
123.	-103.0	123.	148.1	123.	-81.1	71.	-5.8
124.	-103.8	124.	149.3	124.	-81.8	72.	-5.9
125.	-104.6	125.	150.5	125.	-82.4	73.	-5.9
126.	-105.5	126.	151.7	126.	-83.1	74.	-6.0
127.	-106.3	127.	152.9	127.	-83.7	75.	-6.1
128.	-107.1	128.	154.1	128.	-84.4	76.	-6.2
129.	-108.0	129.	155.3	129.	-85.1	77.	-6.3
130.	-108.8	130.	156.5	130.	-85.7	78.	-6.4
131.	-109.7	131.	157.7	131.	-86.4	79.	-6.4
132.	-110.5	132.	158.9	132.	-87.0	80.	-6.5
133.	-111.3	133.	160.1	133.	-87.7	81.	-6.6
134.	-112.2	134.	161.3	134.	-88.4	82.	-6.7
135.	-113.0	135.	162.5	135.	-89.0	83.	-6.8
136.	-113.8	136.	163.7	136.	-89.7	84.	-6.8
137.	-114.7	137.	164.9	137.	-90.3	85.	-6.9
138.	-115.5	138.	166.1	138.	-91.0	86.	-7.0
139.	-116.3	139.	167.3	139.	-91.7	87.	-7.1

(NOM)

\dot{R}_{28}	(113.5)	\dot{R}_{30}	-(113.2)	\dot{R}_{30}	-(113.2)
\dot{R}_{32}	(112.8)	\dot{R}_{10}	(116.2)	F_{10}	(-76.6)
R_{10}			(62.2)	G_{10}	(- 5.0)
				$F_{30} + F_{10} + G_{10}$	(-176.4)
\dot{R}_{20}			(114.7)	F_{20}	(138.3)
				ΔV_{CSI}	(-38.1)

**MISSION COM CHART
1-21-69**



D. MISION

130. TRANSFER
10-3-68

TPI₀ FIRST OPPORTUNITY ONLY

FIRST OPPORTUNITY ONLY

10-3-68 130° TRANSFER

CHARTS

PHNGS	GND	CHARTS	ΔT	ΔV	$\Delta \Theta$
\dot{r}_A					
\dot{r}_L					
\dot{r}_U					

Top Grid Labels:

- T_{E_H} ————— 29.6
- $\Delta T_N +$ 1:01:45
- T_{E_N} —————
- T_{E_S} —————
- ΔT_E ————— 3.67
- R_{-5} ————— 20.2
- Θ_{-5} ————— 20.76
- Θ_{-6} ————— 17.09
- ΔR —————
- $\Delta \Theta$ —————
- R_{REQ} ————— 137.2
- ΔT_N ————— 1.02
- ΔV_N ————— -17.0
- $\Delta \Theta_N$ ————— -4.8
- ΔV_E ————— 0.0
- $\Delta \Theta_E$ ————— -4.8
- ΔV_C ————— -4.8
- $\Delta \Theta_C$ ————— -4.8

Bottom Grid Labels:

- R_{-5} 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
- ΔT 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
- ΔV 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
- $\Delta \Theta$ 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

MISSION

LM-120 CSM-130
130 DEGREE TRANSFER
9-17-68

TERMINAL PHASE INITIATION

PHASE 2 SET Z 4 JET X R(NM) 5 5 8 14 5

R_{reg} — 120.7

• 88

二二

$$\Delta R = \frac{1}{21.8}$$

CHARTS

26.25

卷之三

9.73

1.39

GND

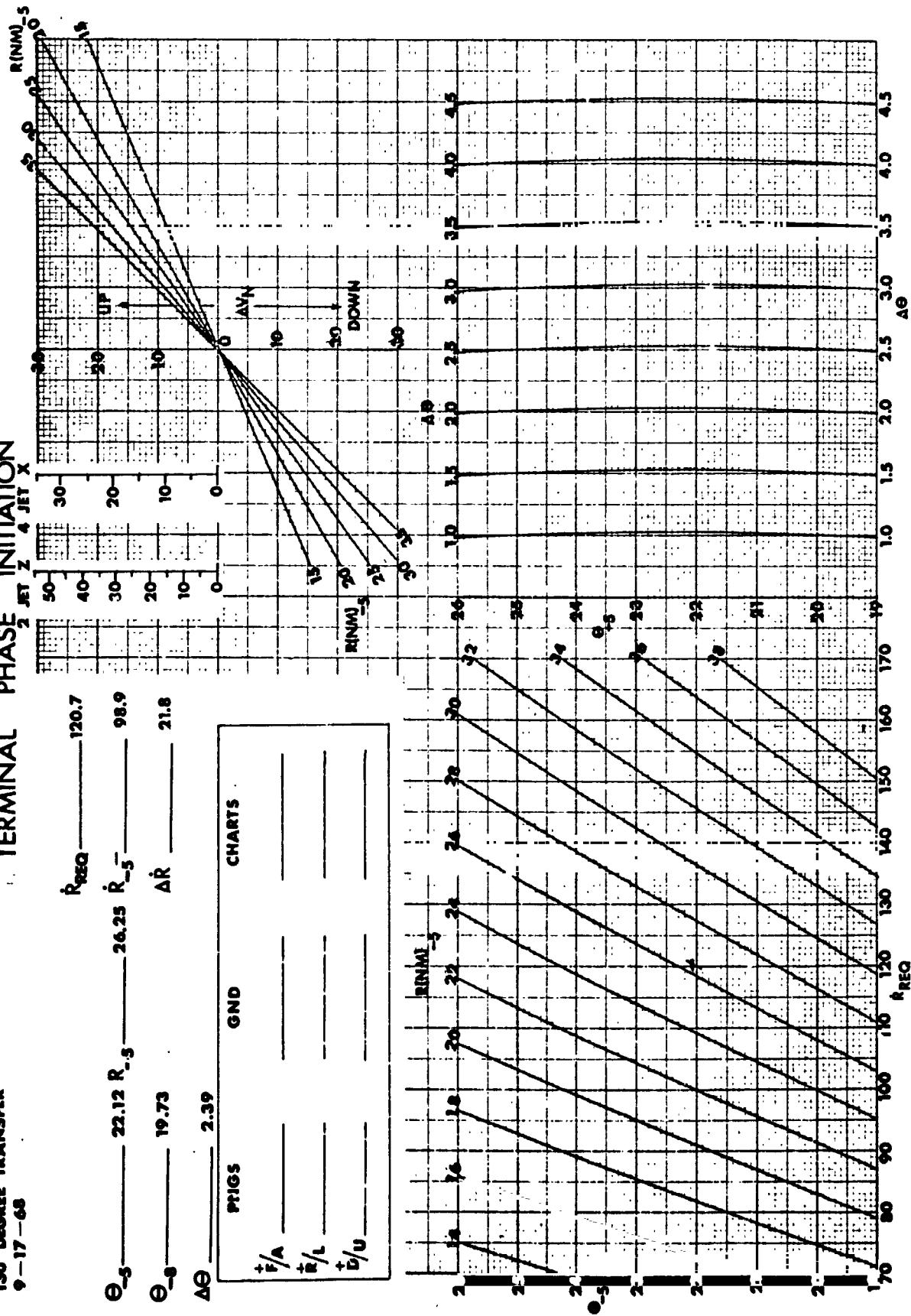
2

110

15

Δe —

PIRES



LM-120 CSM-130
130 DEGREE TRANSFER
9-17-68

ט' ינואר

DEGREE TRANSFER - 17-68

CORRECTION

MIDCOURSE

FIRST

R_{REQ} _____ 97.4
 R_g _____ 12.90 R_g _____ 97.4
 ΔR _____ 0.0
 $\Delta\theta$ _____ 5.38

CHARTS

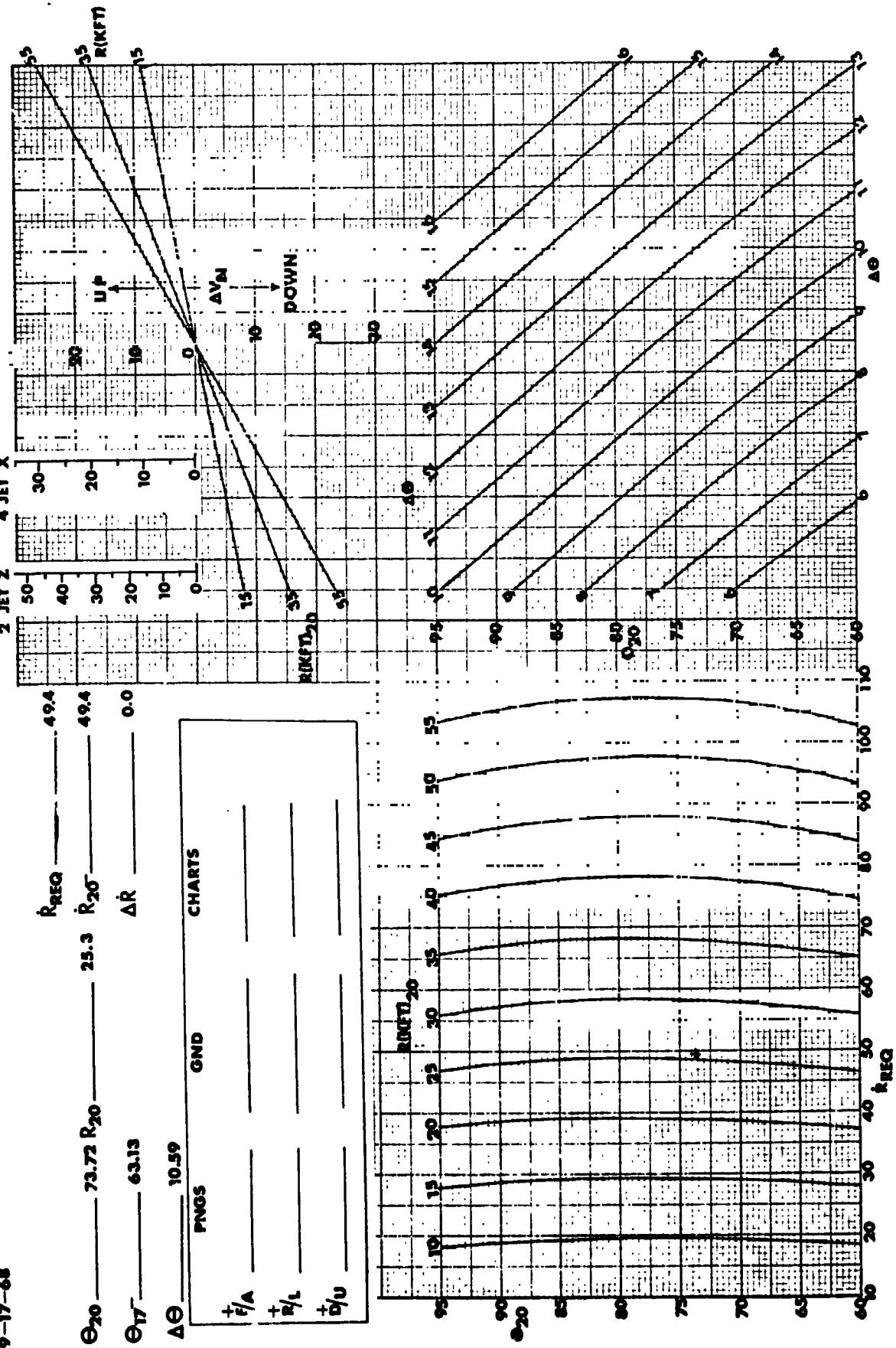
γ_A _____
 γ_L _____
 γ_U _____

UP DOWN AVN PNT GND RREQ

DEGREE TRANSFER - 17-68

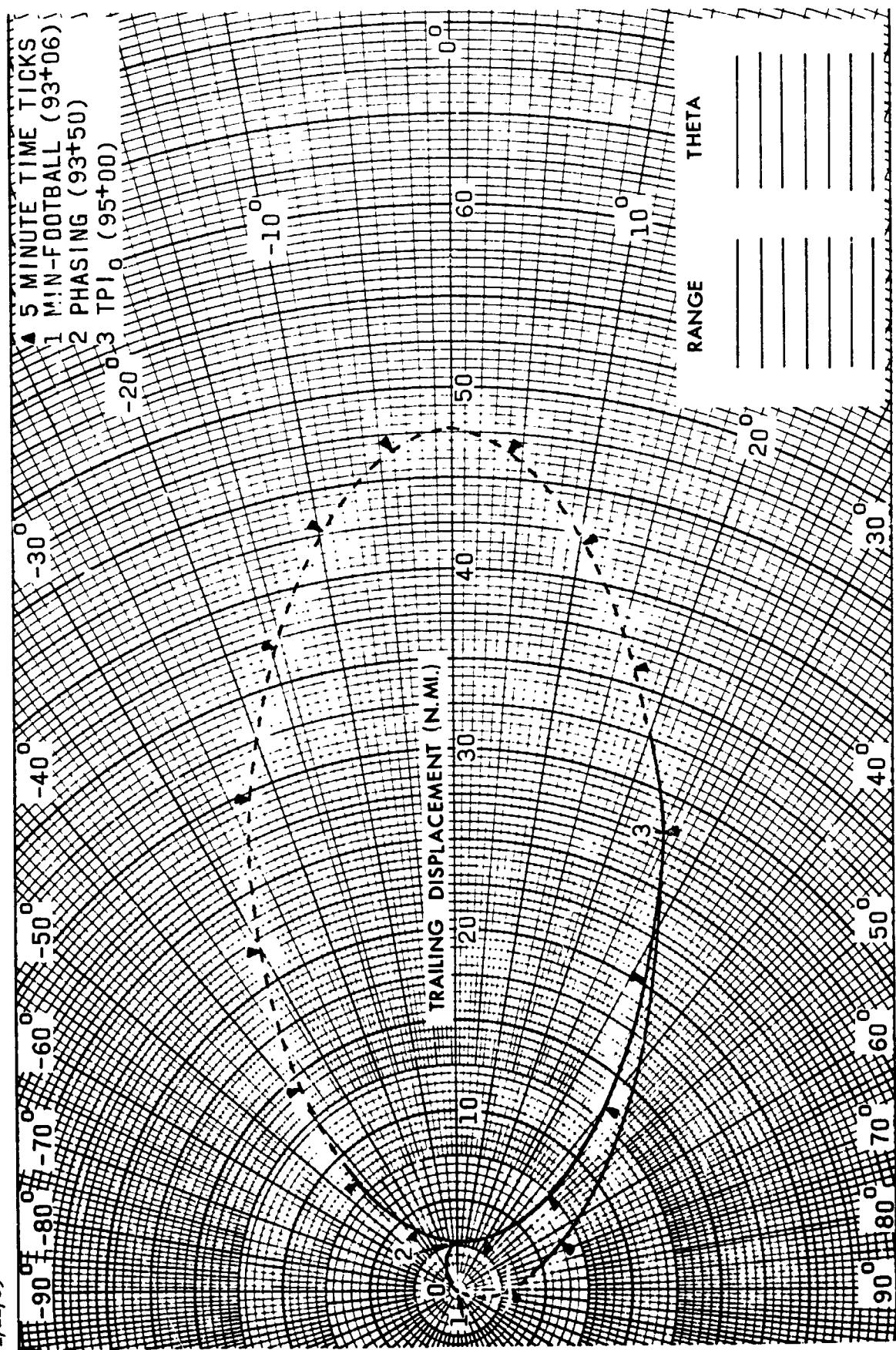
9-17-98 130 DEGREE TRANSFER CSM-130

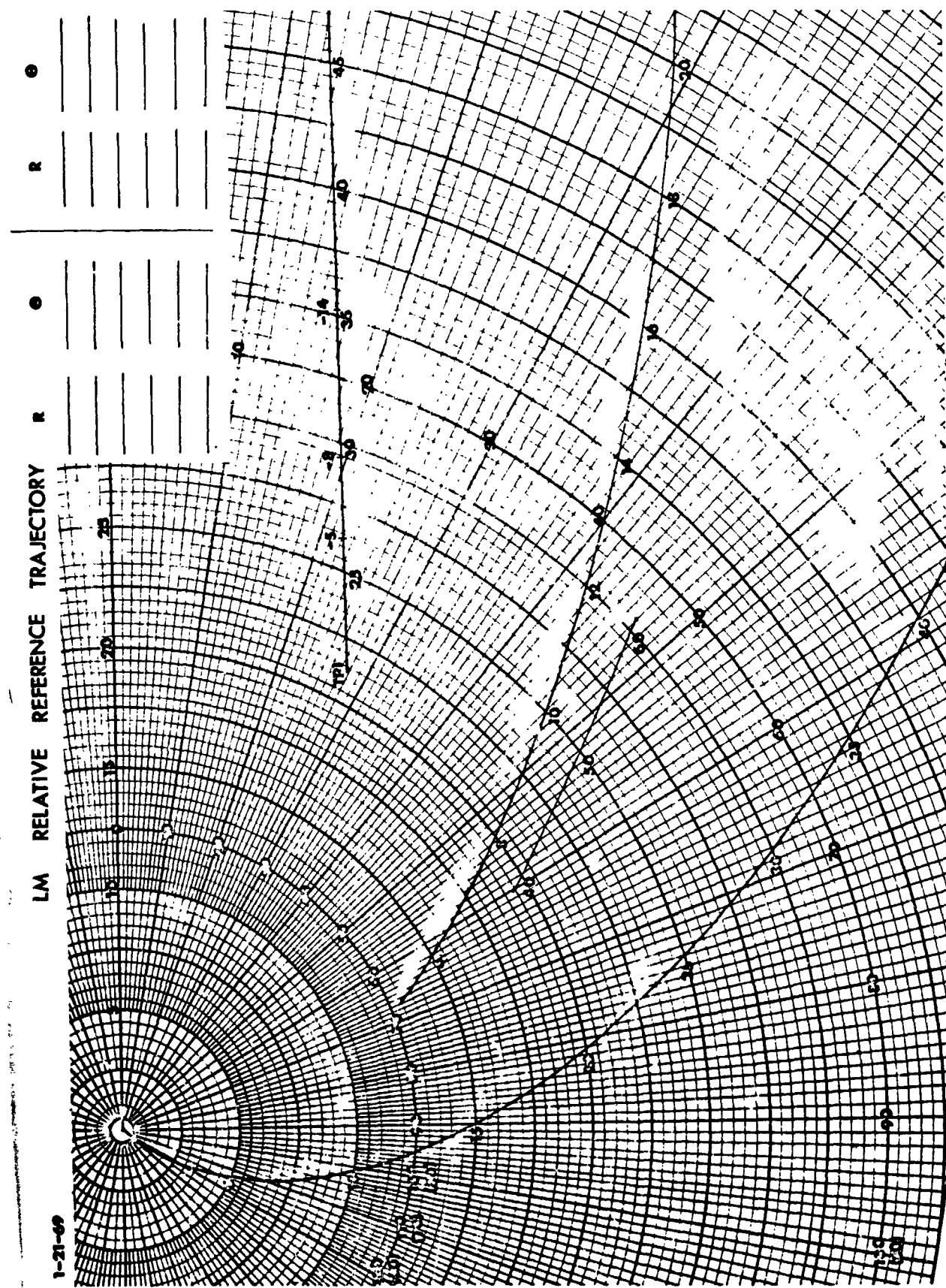
SECOND MIDCOURSE CORRECTION



1/22/69

LM FOOTBALL REFERENCE TRAJECTORY





6.0 References

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- 6.2 Apollo Mission D (AS-504/CSM-104/LM-3) Spacecraft Operational Trajectory, Mission Profile, Volume 1, dated December 2, 1968.
- 6.3 Guidance System Operations Plan, Sundance, Volume II, MIT R-557, dated July 1968.
- 6.4 Apollo Operations Handbook, Lunar Module, LMA790-3-LM3, Volume 2, Operational Procedures, dated August 15, 1968.
- 6.5 Apollo 9 Preliminary Flight Plan, Flight Crew Support Division, dated December 11, 1968.
- 6.6 S-PA-8M-036, Apollo Mission Techniques Mission D Rendezvous, Volume 1, dated December 20, 1968.
- 6.7 Apollo 9 Flight Mission Rules (AS-504/104/LM-3), Flight Control Division, dated December 15, 1968.